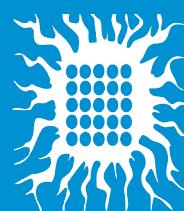


# 2016 - 2017 ANNUAL REPORT

GODIŠNJAK



*Institut za nuklearne nauke „Vinča“*



# Predgovor

Pred vama je dvogodišnjak - ilustracija rezultata i dostignuća Instituta „Vinča“ u prethodne dve godine, 2016. i 2017.

Institut Vinča pripada naučnim ustanovama čiju delatnost čine osnovna istraživanja, praćena primjenjениm istraživanjima, kojasu u funkciji valorizacije rezultata osnovnih istraživanja od opštег nacionalnog, odnosno strateškog značaja za Republiku. Jedinstven je po multidisciplinarnosti svojih naučnih kapaciteta, sa jedinstvenom infrastrukturom za najambicioznejše istraživačke projekte.

Od osnivanja, Institut je doprineo da Jugoslavija, zajedno sa Srbijom, bude uvršćena u prvi pet nuklearnih sila po znanju i naučnim dostignućima. Rad na nuklearnim istraživanjima iziskivao je angažovanje velikog broja različitih struka, čime je stican širok spektar znanja. Rezultat ovih aktivnosti je dao direktni doprinos razvoju privrede države i svih njenih delatnosti, od zdravstva i odbrane do obrazovanja, kao i čitavog niza savremenih delatnosti i institucija.

Institut Vinča je član Univerziteta u Beogradu i njegovi istraživači od osnivanja aktivno učestvuju u izvođenju osnovnih, poslediplomskih i doktorskih studija. U Institutu svake godine doktorira između 20 i 30 istraživača, a najmanje još toliko sa Univerziteta uradi svoje doktorske disertacije u Vinči. Na ovaj način, naučni kadar Instituta značajno doprinosi poboljšanju kvaliteta nastave na srodnim fakultetima Univerziteta u Beogradu i aktivno učestvuje u procesu razmene znanja i stvaranja modela interakcije nauka–obrazovanje u Srbiji.

Danas je u Institutu zaposleno 311 doktora nauka, i 210 doktoranata koji rade na preko stotinu nacionalnih i međunarodnih projekata kao i u međunarodnim naučnoistraživačkim kolaboracijama u kojima je Republika Srbija član. Široka i stalna međunarodna naučna i stručna razmena Instituta sa svetom, doprinela je da država stekne i naučni i diplomatski ugled u inostranstvu, na svim kontinentima.

Kroz kapije Instituta Vinča godišnje prođe preko 1000 učenika i studenata, koji učestvuju u specijalnim edukativnim programima Instituta, skrojenim prema potrebama uzrasta kojem pripadaju. Kroz ove programe mladi stiču osnovne pojmove o funkcionisanju nauke i njenim metodološkim principima, kao i osnovna znanja iz oblasti koje ih posebno interesuju. To je značajan doprinos formiranju ljudskog resursa zemlje i oslonac njenog razvoja u budućnosti.

Dr Milica Marčeta Kaninski  
Direktor instituta za nuklearne nauke „Vinča“

# Foreword



Before you is a biannual - an illustration of the results and achievements of the Vinča Institute in the previous two years, 2016 and 2017. Vinča Institute belongs to scientific institutions whose activity is fundamental research, followed closely by applied research, through which the results of the fundamental research are valorized, of general national and strategic significance to the Republic of Serbia. It is unique by the multidisciplinarity of its scientific capacities, with a unique infrastructure for the most ambitious research projects.

Since its founding, the Institute has contributed to placing Yugoslavia, together with Serbia, into, historically, the first five nuclear powers in terms of knowledge and scientific achievements. The work on nuclear research meant engagement of a large number of different expertises, creating a wide spectrum of knowledge. The result of these activities directly contributed to advancement of the country's economy, and all its components, from health care and defense to education, as well as a whole array of modern operations and institutions.

Vinča Institute is a member of the University of Belgrade, and, since day one, its researchers have been taking an active part in undergraduate, postgraduate, and PhD teaching. Every year, between 20 and 30 Institute's researchers obtain the PhD title, and at least that many University researchers complete their PhD theses at Vinča. This way, the research staff of the Institute significantly contributes to advancing the quality of teaching at the University, and takes an active part in knowledge exchange, together with establishing a science-and-education model in Serbia.

Today, the Institute employs 311 PhDs, while 210 PhD students work on more than 100 national and international projects, as well as in international scientific collaborations in which Serbia is a member. The wide and continuous international scientific and expert exchange with the world has contributed to Serbia's reputation in science and diplomacy, across the continents.

Through Vinča's gates more than 1000 highschool and university students pass each year, taking part in specialised educational programmes of the Institute, tailored to their age level. These programmes are instrumental in forming their basic concepts of how science functions, and its methodological principles, at the same time giving them basic knowledge in areas of their special interest. This is a significant contribution to creating the human resource of the country, and the support for its development in future.

Dr Milica Marčeta Kaninski  
Director of the Vinča Institute of Nuclear Sciences

# Laboratorije i centri

**Laboratorija za fiziku**  
**Department of Physics**

**Laboratorija za nuklearnu i plazma fiziku**  
**Department of Nuclear and Plasma Physics**

**Laboratorija za teorijsku fiziku i fiziku kondenzovane materije**  
**Department of Theoretical Physics and Condensed Matter Physics**

**Laboratorija za radijacionu hemiju i fiziku**

**Department of Radiation Chemistry and Physics**

**Laboratorija za atomsku fiziku**

**Department of Atomics Physics**

**Laboratorija za fizičku hemiju**

**Department of Physical Chemistry**

**Laboratorija za hemijsku dinamiku i permanentno obrazovanje**

**Department of Chemical Dynamics and Permanent Education**

**Laboratorija za radioizotope**

**Department of Radioisotopes**

**Laboratorija za radiobiologiju i molekularnu genetiku**

**Department of Radiobiology and Molecular Genetics**

**Laboratorija za molekularnu biologiju i endokrinologiju**

**Department of Molecular Biology and Endocrinology**

**Laboratorija za zaštitu od zračenja i zaštitu životne sredine**

**Department of Radiation and Environmental**

**Laboratorija za termotehniku i energetiku**

**Department of Thermal Engineering and Energy**

**Centar za motore i vozila**

**Department of Engines, Vehicles and related Technologies**

**Laboratorija za materijale**

**Department of Materials**

**Centar za multidisciplinarna istraživanja i inženjeringu**

**Department of Multidisciplinary Research**

**Spoljnotrgovinski promet**

**The Foreign Trade Division**

**Centar za protiveksplozionu zaštitu**

**Department of Anti-explosion Protection**

**Spoljnotrgovinski promet**

**The Foreign Trade Division**

**Biro za sertifikaciju**

**Certification Bureau**

Institut je organizovan u vidu radnih i istraživačkih jedinica koje se, po tradiciji iz 1948. nazivaju laboratorije, a koje su posle gašenja jugoslovenskog nuklearnog programa 1968. godine u dobroj meri samostalne u radu.

*Departments are the organizational units of the Institute since its founding in 1948. After the Yugoslav nuclear program was closed down in 1968 they were given substantial autonomy in their activities.*

# Vinča Institute Departments

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# LABORATORIJA ZA FIZIKU

## DEPARTMENT OF PHYSICS

### O N A M A

Laboratorijska za fiziku, koja je prva osnovana u Institutu "Vinča", ima 50 saradnika koji su raspoređeni u pet sektora/grupa - jedan administrativni i četiri istraživačka.  
Oni su angažovani i rukovode sa 3 nacionalna, 11 međunarodnih i 5 bilateralnih projekata.

Osnovna delatnost Laboratorije je naučno-istraživački rad u oblastima nauke o materijalima, kao i pružanje usluga istraživačima iz zemlje i inostranstva u okviru korisničkog postrojenja FAMA za istraživanja u oblasti modifikacije i analize materijala lakis i teškim jonima. Takođe, Laboratorijska ima razvijenu aktivnost u oblasti fizike visokih energija. Treba istaći da postrojenje FAMA predstavlja najveći i najvredniji deo istraživačke infrastrukture u Srbiji i da je od 30. oktobra 2017. god, primljena u CERIC-ERIC konzorcijum koji finansira Evropska komisija.

Takođe, centar izuzetnih vrednosti vezan za problematiku skladištenja vodonika za obnovljive izvore energije – CONVINCE, nalazi se u Laboratorijskoj za fiziku.

Excellence in science  
CONVINCE - CERIC



Hydrogen sorption analyzer  
Patent pending

CERIC-ERIC consortium  
[www.ceric-eric.eu](http://www.ceric-eric.eu)

### A B O U T U S

Laboratory of Physics, the first Laboratory established at Vinča Institute, has 50 employees, divided into five sectors – administrative and four research ones.  
Researchers and some of them lead three national, 11 international and participate in five bilateral projects.

The main activity of the Laboratory is basic scientific research in the fields of material science, as well as providing services to researchers from home and abroad in the context of FAMA user facilities for research in the field of modification and analysis of materials with light and heavy ions. Relevant aspect of our basics research is in the field of high energy physics (HEP). It should be noted that FAMA is the largest and most valuable part of the research infrastructure in Serbia, and that of 30 October 2017, it is admitted to the CERIC-ERIC consortium funded by the European Commission. Also, the Center of Excellence linked to the problem of stockpiling of hydrogen for renewable sources of energy- CONVINCE, is located in Laboratory of Physics.



Home made  
TPD -MS



FAMA facility

### Osnovna eksperimentalna oprema Laboratorijske za fiziku

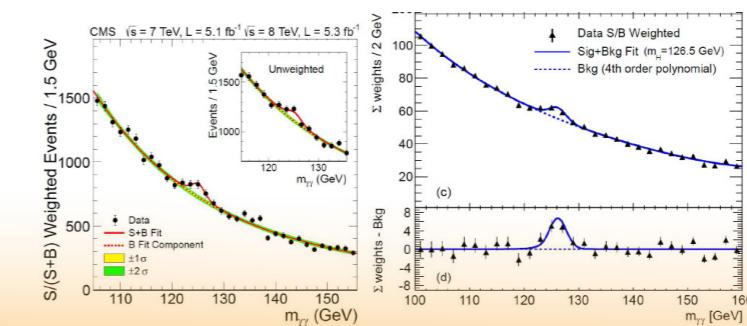
Basic experimental equipment of the Department of Physics

### Grupa za nauku sa akceleratorima

Istraživački deo projekta III45006: "Fizika i hemija sa jonskim snopovima", koji čine saradnici u Grupi za nauku sa akceleratorima, angažovani su u okviru sledećih aktivnosti: proizvodnja, dijagnostika i dinamika jonskih snopova; Implantacija i kanalisanje jona u kristalima i nanocevima i nanomodifikacija i analiza materijala jonskim snopovima.

### Grupa za nove materijale

Grupa za nove materijale se u odeljenju za separacionu hemiju i obnovljive izvore energije bavi razvojem i primenama separacionih i elektrohemimskih metoda u biomedicini i zaštiti životne sredine. Ove aktivnosti su takođe finansirane kroz projekat III45006. U okviru projekta III45012: "Sinteza, procesiranje i karakterizacija nanostrukturnih materijala za primenu u oblasti energetike, mehaničkog inženjerstva, zaštite životne sredine i biomedicine", saradnici odeljenja za vodonučnu energiju rade na sintezi, modifikaciji i karakterizaciji materijala za skladištenje vodonika i obnovljive izvore energije.



Istraživači iz Laboratorijske za fiziku koji rade u Grupi za fiziku visokih energija i Grupi za fiziku elementarnih čestica, potpisuju radove ATLAS i CMS kolaboracija o otkriću Higsovog bozona za čije je postuliranje dodeljena Nobelova nagrada za fiziku 2013. godine.

Researchers from the Laboratory of Physics, involved in the Experimental HEP group and the Group for physics of elementary particles, have signed the Higgs discovery papers of ATLAS and CMS collaborations at LHC.

### Grupa za fiziku visokih energija

Grupa za fiziku visokih energija realizuje aktivnost Laboratorijske za fiziku i Institutu Vinča na projektima budućih electron-positronskih sudarača visokih energija ILC, CEPC i CLIC. Istraživanja su usmerena na fizičku na Higsovom bozonu, u smislu merenja sprezanja Higsovog bozona sa elektroslabim bozonima, leptonima drugih generacija i fotonima. Takođe, u fokusu su i ispitivanja mogućnosti novih sudarača u pogledu merenja CP strukture Higsovog bozona. Značajan deo aktivnosti grupe odnosi se na istraživanje i razvoj detektora prednje oblasti za e+e- sudarače i, posebno, na merenje integralne luminoznosti ovih mašina. Ove aktivnosti realizuju se u okviru nacionalnog projekta OI171012, kao i u okviru međunarodnih projekata HORIZON2020 AIDA2020 i HORIZON2020 E-JADE.

Aktivnošću ove grupe Institut Vinča ostvaruje članstvo u kolaboracijama FCAL i ILD na projektu ILC, CLIC i CLICdp na projektu CLIC i u kolaboraciji CEPC na istoimenom projektu.

### Grupa za fiziku elementarnih čestica

Saradnici grupe za fiziku elementarnih čestica angažovani su preko projekta OI171019: "Fizika visokih energija sa detektorom CMS". Njihove aktivnosti mogu se razvrstati u okviru tri grupe: (1) fizika na hadronskim sudaračima, dominantno orijentisana na proučavanje osobina Higgs bozona, njegovog sprezanja sa top kvarkom u okviru i izvan SM, sa posebnim fokusom na globalnu rekonstrukciju dogadjaja kao i kalibraciju energije mlazova hadrona u sistem Trigger za "online" prikupljanje podataka. (2) fizika sudarača teških jegara u kojoj se istražuju osobine kvark-gluonske plazme (QGP) stvorene u AA, pA i pp sudarima na LHC-u analizom eksperimentalnih podataka i simuliranih podataka iz teorijskih modela. Fokus istraživanja je na kolektivnom ponašanju QGP-e i uticaju fluktuacija početnih stanja na tu kolektivnost. (3) Primjenjena fizika čestica, multidisciplinarnim pristupom u istraživanjima, kombinovanjem znanja iz fizike, biologije i medicine, ispituje direktnе i indirektnе efekte hadrona na normalnim i malignim transformisanim celijama čoveka. Eksperimentalni rezultati se porede i tumače koristeći i dalje razvijajući numerički simulacioni program GEANT4 (GEometry ANd Tracking), u cilju da se poboljšaju protokoli u hadronskoj terapiji kancer. Deo ovih istraživanja je omogućen i preko projekta OI173046.

### Group of science with accelerators

Research part of the project III45006: "Physics and Chemistry with ion beams", engages collaborators of the Group of Science with accelerators in the following activities: Production, diagnostics and the dynamics of ion beam; Implantation and channeling of ions in the crystals and the nanotubes and Nano modification and analysis of materials by ion beams.

### Group for new materials

Group for new materials in the section of chemistry separation and renewable energy is engaged in the development and application of separation, and electrochemical methods in biomedicine and environmental protection. These activities are also financed through the national project III45006. Within the project III45012: "Synthesis, processing and characterization of nanostructured materials for application in energetics, mechanical engineering, environmental protection and biomedicine", researchers in the hydrogen energy section work on the synthesis, modification and characterization of materials for hydrogen storage and renewable energy.

### Experimental HEP Group

Experimental HEP group is predominantly oriented towards physics and detector R&D at future e+e- colliders: ILC, CLIC and CEPC. In particular, they are focused on precision measurements in the Higgs sector, either related to the Higgs couplings to EW bosons, muons and photons, or to the study of the Higgs CP properties. Their focus is also on detector R&D for the future electron-positron colliders, in particular in the MDI region, with emphasis on the integral luminosity measurement. This activity is supported through the national project OI171012, as well as through the HORIZON2020 projects AIDA2020 and E-JADE.

Through this activity, Vinča Institute realizes participation in the HEP collaborations: FCAL and ILD at ILC, CLIC and CLICdp at CLIC and CEPC Collaboration at CEPC.

### Group for physics of elementary particles

Researchers working in the Sector for elementary particle physics are funded by the project OI171019: "High energy physics with CMS detector". Their activities are mainly within the following three subjects: (1) hadron collider physics, predominantly oriented towards studying the Higgs boson properties, its couplings to the top quark within and beyond the Standard Model, with the particular emphasis on the global event reconstruction, as well as on the jet energy calibrations within the online "Trigger" system. (2) Physics of heavy-ion collisions in which properties of the quark-gluon plasma (QGP) created in AA, pA and pp collisions at the LHC are analyzed using the experimental data and data simulated within the theoretical models. In the focus of these investigations is collective behavior of the QGP and the influence of the initial-state fluctuations on it. (3) Applied particle physics, having multidisciplinary approach in research by combining knowledge from physics, biology and medicine, investigates direct and indirect effects of hadrons on human normal and malignant cells. Experimental results are compared and interpreted by using and further developing the numerical simulation toolkit GEANT4 (GEometry ANd Tracking), with the final aim to improve protocols in hadron therapy of cancer. Part of these studies are enabled through project no.OI173046.

# LABORATORIJA ZA NUKLEARNU | PLAZMA FIZIKU

## DEPARTMENT OF NUCLEAR AND PLASMA PHYSICS

### O N A M A

Laboratorijska za nuklearnu i plazma fiziku, kao deo originalne Laboratorije za fiziku, jedna je od najstarijih Laboratorijskih Instituta.

Laboratorijska za nuklearnu i plazma fiziku ima 26 zaposlenih, od toga 18 doktora nauka.

U prethodne dve godine (2016-17), radnici laboratorijske objavili su 42 radova u vodećim međunarodnim časopisima. Glavne istraživačke delatnosti Laboratorijske za nuklearnu i plazma fiziku su nuklearna spektroskopija i reakcije, nuklearna instrumentacija i metode, hiperfine interakcije, ispitivanje lokalnih struktura i klastera, ispitivanje materijala za vodoničnu energetiku, akceleratorska fizika, detektori zračenja, organska (opto)elektronika i spintronika i ekologija i održivi razvoj.

**Saradnici Laboratorijske za nuklearnu i plazma fiziku su posvećeni pedagoškom radu i obuci mlađih istraživača. Jedinstvena aktivnost laboratorijske je i izdavačka delatnost – 22-godišnja tradicija publikovanja rezultata istraživanja u Laboratorijskoj formi Godišnjeg izveštaja na engleskom jeziku (ISSN 1450-6092).**

Neke od priznatih naučno-istraživačkih institucija sa kojima je Laboratorijska ostvarila saradnju su: GANIL, Caen, Francuska; Helmholtz-Zentrum Berlin, Nemačka; GSI, Johannes Kepler University, Linz, Austrija; Jožef Stefan Institut, Ljubljana, Slovenija; Rudjer Bošković Institut, Zagreb, Hrvatska; Institute of radiation physics, Lozana, Švajcarska; Fakultet za nauku i tehnologiju, Portugalija; LNEG, Portugalija; Condensed Matter Physics and Materials Science Department, Brookhaven National Laboratory, Upton, New York, USA; EC-JRC Institute for Reference Materials and Measurements (IRMM), Radionuclide Metrology Sector, Geel, Belgija, ENEA, Rim, Italija itd. Rome, Italy etc.

### A B O U T U S

Laboratorijska za nuklearnu i plazma fiziku, kao deo originalne Laboratorije za fiziku, jedna je od najstarijih Laboratorijskih Instituta.

It has 26 employees out of which 18 with PhD degree.

In 2016-2017 collaborators has published 42 publications in international scientific journals.

Main research activities are Nuclear Spectroscopy, Nuclear Reactions, Hyperfine Interactions, Local Structures and Clusters, Hydrogen Storage Materials, Nuclear Instruments and Methods, Accelerator Physics, Radiation Detectors, Organic (Opto)Electronics and Spintronics, Ecology and Sustainable Development.

**One of the most important facets of the Laboratory is the devotion of its research staff to pedagogical activities and training of junior researchers by leading BSc, MSc and PhD. Also, Laboratory is distinct in its 22 year long tradition of research results publication in form of Annual report (ISSN 1450-6092).**

International cooperation is another intensive and recognized feature of the Laboratory. Some of the most distinguished scientific institutions Laboratory is collaborating with are: GANIL, Caen, France; Helmholtz-Zentrum Berlin, Nemačka; GSI, Johannes Kepler University, Linz, Austria; Jožef Stefan Institut, Ljubljana, Slovenija; Rudjer Bošković Institut, Zagreb, Hrvatska; Institute of radiation physics, Lozana, Švajcarska; Fakultet za nauku i tehnologiju, Portugalija; LNEG, Portugalija; Condensed Matter Physics and Materials Science Department, Brookhaven National Laboratory, Upton, New York, USA; EC-JRC Institute for Reference Materials and Measurements (IRMM), Radionuclide Metrology Sector, Geel, Belgija, ENEA, Rim, Italija itd. Rome, Italy etc.

- Improving the *Photocatalytic Properties of Anatase TiO<sub>2</sub> (101) Surface by Co-doping with Cu and N: Ab Initio Study*, Applied Surface Science 425 (2017) 1095-1100

- Mapping the Proton Drip Line in the Vicinity of <sup>100</sup>Sn: Identification of New Isotopes and Proton Emitters*, Physical Review Letter, 116 (2016), 162501

- Analizator Sorpcije Vodonika HSA ULNS razvijen i napravljen u saradnji sa preduzećem iz Srbije UNO LUX NS – patentna prijava u obradi.

**Hydrogen Sorption Analyzer HSA ULNS developed and built in cooperation with Serbian company UNO LUX NS – Patent pending.**

### GRUPA ZA METROLOGIJU I RADIONUKLIDE

Glavne aktivnosti Grupe za metrologiju radionuklida su vezane za aktivnosti unutar projekta **171018** i prvenstveno su usmerene na eksperimentalna ispitivanja granica nuklearne fizike, metode i primene kroz izučavanja: nuklearne strukture, nuklearne astrofizike, metrologije radionuklida i njihovu primenu, razvoj nuklearnih detektori i instrumentacije, kao radioekologiju i zaštitu od zračenja uz bogatu saradnju sa stranim centrima izvrsnosti.

### Nuklearna struktura i nuklearna astrofizika

- Rukovođenje eksperimentom "Evolution of collectivity around N=40:lifetime measurements in <sup>73,75</sup>Ga" sprovedenim u GANIL-u, Caen
- Otkriće 8 novih izotopa, nekoliko protonskih emitera i sub-μs izomera u okolini dvostruko magičnog <sup>100</sup>Sn
- Izvršeno do sada najpreciznije merenje vremena života <sup>19</sup>Ne i postavljena osnova za ultra-precizna merenja vremena života izotopa sa periodom poluraspada reda sekunde
- Ispitivanja nuklearna struktura nevezanog <sup>15</sup>F izotopa. Rezultati ukazuju na mogućnost ispitivanja čestične i gama rezonantne spektroskopije u jezgrima daleko izvan linije curenja

### Nuklearni instrumenti i metode

- Rad na razvoju ultrabrzih kalorimetara, testiranih na protonskim, mionskim i pionskim snopovima
- Razvijen metod merenja ekshalacije radona iz građevinskog materijala, jedinstven po tome što se pored brzine ekshalacije, određuje i difuziona dužina i faktor emanacije
- Uspešno učestvovanje u 2 međunarodne interkomparacije organizovane od strane IAEA i EC sa zadatom određivanja sadržaja radionuklida u različitim matriksima spajkovanim sa sertifikovanim rastvorom radionuklida
- Detaljna eksperimentalna provera softvera ANGLE 4*
- Nastavak na razvoju metoda određivanja površine velikog broja pikova u gama spektrima, a sa velikom statističkom greškom
- Izučavanje metoda koincidentnog sumiranja kod NaI(Tl) scintilacionih detektora i HPGe detektora
- Ispitivani efekti koincidentnog sumiranja X i γ zraka kod <sup>152</sup>Eu korišćenjem DMM metoda razvijenog u Laboratorijskoj. Validacija potvrđena korišćenjem GESPECOR 4.2 programa
- Pravljenje radioaktivnih standarda u različitim matriksima spajkovanim sa sertifikovanim rastvorom radionuklida

### Radioekologija

- Uvedena tehnika merenja radona u zemlji, ispitivani parametri koji utiču na ekshalaciju radona
- Učestvovanje u Nacionalnom programu merenja radona u Srbiji
- Ispitivanje brzine jezerske sedimentacije na osnovu ispitivanja sadržaja <sup>137</sup>Cs i <sup>210</sup>Pb, a u cilju ispitivanja uticaja na ekosisteme sa stanovišta algologije.

### RADIONUCLIDES & METROLOGY GROUP

The main activity of Radionuclide Metrology Laboratory are related to the activities defined within the **Project 171018** and are related to experimental investigation of frontiers of nuclear physics, methods and applications by investigating: nuclear structure, nuclear astrophysics, radionuclide metrology and application, development of nuclear detectors and instrumentation as well as radioecology and radiation protection in collaboration with foreign centers of excellence.

### Nuclear Structure and Nuclear Astrophysics

- Conducting and managing of experiment: "Evolution of collectivity around N=40: lifetime measurements in <sup>73,75</sup>Ga" performed in GANIL, Caen, France
- Discovery of 8 new isotopes, a few proton emitters and sub-microsecond isomers in the vicinity of doubly-magic <sup>100</sup>Sn
- Performed the most precise half-life measurement of <sup>19</sup>Ne up to now; established a basis for ultra-precise measurements of nuclei (half-lives of the order of seconds)
- Investigated nuclear structure of unbound nucleus <sup>15</sup>F. Results of the research are opening a possibility for the particle and γ resonance spectroscopy in nuclei far beyond the drip lines

### Nuclear Instruments and Methods

- Working on development of ultra-fast calorimeters, tested in proton, muon and pion beams
- Developed method for radon exhalation rate measurement from building material; method is unique since beside radon exhalation measurement it provides a value of diffusion length and emanation factor (resulted in 1 PhD thesis)
- Successful participation in 2 international intercomparisons organised by IAEA and EC with the goal to determine activity concentration of nuclei in different matrices. Conclusion: an excellent ranking of the Laboratory on international level
- Detailed experimental verification of the software ANGLE 4*
- Development of method to determine the net area of large number of peaks in γ spectra, with a large statistical error
- The coincident summing phenomenon for the NaI(Tl) and HPGe detector was studied
- The coincident summing phenomena in <sup>152</sup>Eu investigated, using DMM method developed in our Laboratory. Validation confirmed using GESPECOR 4.2 programme.

### Radioecology

- Introduced technique of measurement of radon in soil gas; investigated parameters that influence radon exhalation rate
- Participation in National programme of radon measurement in Serbia
- Investigation of the lake sedimentation rate based on measurement of <sup>137</sup>Cs and <sup>210</sup>Pb, aiming to understand an influence on ecosystems from the algology point of view
- Making radioactive standards in different matrix spiked with certified radionuclide solution

Laboratorijska je akreditovana po ISO17025 za ispitivanje radioaktivnosti (gama spektrometrijsku analizu sadržaja radionuklida) u razlicitim uzorcima.

The Laboratory is accredited to perform gamma spectrometric analysis of the environmental samples in accordance with ISO 17025.



Levo: Koincidentni scintilacioni spektrometar

Left: The Time Differential Perturbed Angular Correlations apparatus

Desno: Mesbauerov spektrometar

Right: The Mössbauer spectrometer

## GRUPA ZA NAPREDNE MATERIJALE

Grupa za napredne materijale primjenjuje eksperimentalne tehnike u kombinaciji sa teorijskim proračunima za istraživanja lokalne i elektronske strukture, magnetskih svojstava i relaksacija rešetki oko inkorporiranih nečistoća na nanometarskoj skali.

### Ispitivani sistemi

- Materijali za fotokatalitičke primene (azotom dopiran TiO<sub>2</sub> koji je kodopiran bakrom ili modifikovan korišćenjem plemenitih metala (Pd, Pt), gvođem dopiran TiO<sub>2</sub>, ZnO/PEO kompoziti i ZnO: Fe-nanočestice)
- Superprovodnici na bazi gvožđa (FeS<sub>1-x</sub>Sex, Fe<sub>x</sub> (X = S, Se, Te))
- Superlegure za primene u industriji za hidrocentralne i avioindustriji (Ni<sub>3</sub>Al dopiran sa Mo, Ru, Hf, W, Re)
- Materijali za skladištenje vodonika (Zr-Ni i Hf-Ni intermetalna jedinjenja, YCo<sub>5</sub> i njegovi hidridi, jedinjenja retka zemlja-prelazni metal-Mg ili Ca, AlH<sub>3</sub> polimorfi i LiAlH<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>)
- Materijali za informacione tehnologije (Fe<sub>3-x</sub>GeTe<sub>2</sub>, Au<sub>n</sub>Ti klasteri, BiFeO<sub>3</sub>)

### Metode

- Spektroskopija Mesbauerovog efekta (za merenje hiperfinih interakcija <sup>57</sup>Fe-jezgara proba u uzorku)
- Vremenski razložene perturbowane ugaone korelacije - TDPAC (za merenje hiperfinih interakcija <sup>181</sup>Ta-jezgara proba u uzorku)
- Metoda fine strukture absorpcije X – zračenja (XAFS)
- Proračuni zasnovani na teoriji funkcionala gustine**

## ADVANCED MATERIALS GROUP

The Advanced Materials Group employs experimental techniques in combination with theoretical calculations for investigating local and electronic structure, magnetic properties and relaxation of lattice around incorporated impurities on a nanometer scale.

### Investigated systems

- Materials for photocatalytical applications (nitrogen-doped TiO<sub>2</sub> codoped with Cu or modified using noble metals (Pd, Pt), Fe doped TiO<sub>2</sub>, ZnO/PEO composites and ZnO:Fe – nanoparticles)
- Fe based superconductors (FeS<sub>1-x</sub>Sex, Fe<sub>x</sub> (X = S, Se, Te))
- Superalloys for applications in hydroelectric and aviation industry (Ni<sub>3</sub>Al doped with Mo, Ru, Hf, W, Re)
- Hydrogen storage materials (Zr-Ni and Hf-Ni intermetallic compounds, YCo<sub>5</sub> and its hydrides, rare earth-transition metal-Mg or Ca compounds, AlH<sub>3</sub> polymorphs and LiAlH<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>)
- Materials for information technologies (Fe<sub>3-x</sub>GeTe<sub>2</sub>, Au<sub>n</sub>Ti clusters, BiFeO<sub>3</sub>)

### Methods

- Mössbauer effect spectroscopy (measurement of the hyperfine interactions of <sup>57</sup>Fe-probe nuclei in the sample)
- Time differential perturbed angular correlations – TDPAC (measurement of the hyperfine interactions of <sup>181</sup>Ta-probe nuclei in the sample)
- X-ray absorption fine structure spectroscopy (XAFS)
- Density functional theory based calculations**



Levo: HPGe spektrometar sa prosirenim opsegom (3-3000 keV) rel. eff. 50% i HPGe spektrometar, rel. efikasnosti 30 %

Left: HPGe spectrometer with extended range, rel. eff. 50% and HPGe spectrometer, rel. eff. 30%

Desno: Analizator sorpcije vodonika HSA UNLS

Right: Hydrogen Sorption Analyzer HSA UNLS

## GRUPA ZA LOKALNE STRUKTURE I KLASTERE

Grupa za lokalne strukture i klastere se u okviru laboratorije bavi izučavanjem osobina kristalnih supstanci i molekula na osnovnom, elektronskom nivou i uticajem promena u lokalnoj strukturi na makroskopske osobine ovih materijala.

### Ispitivani materijali

- poluprovodnički materijali II-V i IV-VI tipa (CdTe i PbTe) - razređeni magnetni poluprovodnici sa potencijalnom primenom u elektronici i spintronici,
- materijali sa potencijalnom primenom za skladištenje vodonika - stehiometrijski i instercijski, primesni i kompleksni hidridi alkalnih, emnoalkalnih i prelaznih metala i njihovih oksida, alkalni amidoborani itd.
- materijali od interesa za organsku i hibridnu opto(ektroniku) - različiti oligomeri polianilina PANI.

## GROUP FOR LOCAL STRUCTURES AND CLASTERS

Research interest of Group is investigation of solid state and molecular systems properties at the fundamental, electronic level, and the way the local structure changes influence the macroscopic properties of materials.

### Investigated materials

- II-VI and IV-VI type semiconductors (CdTe and PbTe based) – diluted magnetic semiconductors with potential application in the fields of electronics and spintronics,
- Hydrogen storage materials – stoichiometric and interstitial, doped and complex hydrides of alkali, earthalkali and transition metals and their oxides, alkali amidoboranes,
- Materials for organic and hybrid (opto)electronics – various polyanilin oligomers

### Methods

Theoretical approach encompass numerical calculations of crystal and electronic structure, X absorption and optical properties etc. Various ab initio(DFT- based) and semi empirical methods are used.

Experimental methods include X ray absorption based techniques (XAS, SAX, XMCD, XPS), mechanochemical and hydrogenation synthesis and investigation of kinetics and thermodynamics of hydrogen (de)sorption. For that purpose, the apparatus has been developed and built here in Serbia. Patent is pending for some of the technical solutions applied in construction of this equipment.

### Metode

Teorijski pristup izučavanju pomenutih sistema obuhvata proračune strukture, elektronskih, X i optičkih osobina. U tu svrhu koriste se različite ab initio (DFT) i semiempirijske metode.

Eksperimentalne metode podrazumevaju eksperimentu absorpcionih tehnika sinhrotronskog X zračenja (XAS, SAX, XMCD, XPS), mehanohemiju sintezu materijala za skladištenje vodonika i ispitivanje kinetike i termodinamike sorpcije vodonika. U tu svrhu koristi se uređaj u potpunosti osmišljen i razvijen u Srbiji, a dobijanje patenta za neka tehnička rešenja primenjena na ovom uređaju je u toku.

**Zajedno sa istraživačima Laboratorijske za fiziku, osnovan je "Centar za sintezu, modifikaciju i karakterizaciju materijala za vodoniku energetiku i obnovljive izvore energije CONVINCE".**

**Postupak akreditacije CONVINCE kao centra izuzetnih vrednosti je u toku.**

**Accreditation of CONVINCE as the national center of excellence is in progress.**

# LABORATORIJA ZA TEORIJSKU FIZIKU I FIZIKU KONDENZOVANE MATERIJE

## DEPARTMENT OF THEORETICAL AND CONDENSED MATTER PHYSICS

### KONDENZOVANA MATERIJA

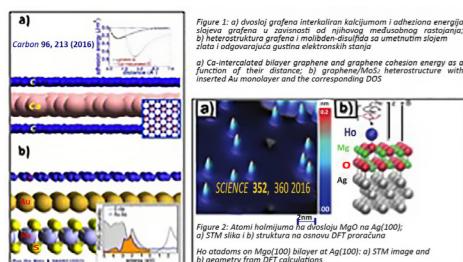
#### KOMPUTERSKO MODELOVANJE MATERIJALA PRIMENOM TEORIJE FUNKCIONALNA GUSTINE (DFT) HETOSTRUKE DVODIMENZIONALNIH(2D) MATERIJALA

Saradnici Laboratorije su primenom DFT pokazali da je umetanjem atoma metala između slojeva grafena, ili unutar heterostruktura 2D materijala, moguće obrazovanje stabilnih jednoslojnih metala jedinstvenih fizičkih osobina. Primeri rezultata objavljenih u poslednje dve godine uključuju interkalaciju dvoслоja grafena atomima kalcijuma (slika 1a) i obrazovanje sloja zlata unutar heterostruke grafena i molibden-disulfida (slika 1b).

### JEDNOATOMSKI MAGNETI

U okviru vrlo uspešne saradnje sa grupom prof. Haralda Bruna (EPFL, Švajcarska), kombinujući eksperimentalne metode grupe iz Švajcarske i kompjuterske proračune istraživača Laboratorije, pokazano je da izolovani atomi holmijuma, adsorbowani na tankim filmovima magnezijum-oksida koji je sintetisan na površini srebra (Fig. 2), predstavljaju najmanje moguće magnete, stabilne na temperaturama do 30 kelvina.

Rezultati ovog istraživanja, finansiranoj od strane švajcarske naučne fondacije, objavljeni su u prestižnom časopisu *Science*.



### KVANTNI METAMATERIJALI

Kvantni metamaterijali su supstance građene od veštačkih atoma tzv. meta-atoma (MA). Kao i prirodni atomi, MA-i imaju diskretan energetski spektar, ali su mezoskopskih razmara i sastoje se od velikog broja ( $\sim 10^9$ ) prirodnih atoma. Glavna osobina MA, koja ih čini posebno interesantnim za različite primene, je mogućnost kontrolisane promene energetskih parametara – energetske razlike između susednih nivoa.

Kombinovanjem više MA moguće je sintetisati KMM-i, grubo rečeno, veštačke kristale sa najčešće jednim MA-om po elementarnoj ćeliji. U upotrebi su nekoliko tipova ovakvih materijala, a posebno interesantnu grupu čine KMM bazirani na superprovodnim "uredajima".

KMM se koriste kao baza u razvoju novih tehnologija- kvantne komunikacione i informacione tehnologije, gde se KMM koriste za kontrolu prostiranja svetlosti i zvuka. Naš najvažniji doprinos je predlog „uredaja“ koji bi mogao značajno usporiti ove talase, i na taj način postići čuvanje informacija - razvoj kvantnih memorija.

QMMs are the base for development of new quantum technologies- quantum information and communication technologies. Our main contribution is proposal of the quantum „device“ which may significantly slow down light and sound waves, which is of interest for information storage–development of quantum memories.

### CONDENSED MATTER

#### COMPUTER MODELING OF MATERIALS BASED ON DENSITY FUNCTIONAL THEORY (DFT) HETOSTRUKE DVODIMENZIONALNIH (2D) MATERIJALA

Researchers from Department of Theoretical Physics (020) applied DFT to demonstrate that the intercalation of graphene bilayer or heterostructures of 2D materials with metal atoms opens prospects to form monolayer metals with unique physical properties. Examples of results published in the last two years include Ca-intercalated bilayer graphene (Fig. 1a) and monolayer Au formed between graphene and monolayer MoS<sub>2</sub> (Fig. 1b).

### SINGLE ATOM MAGNETS

As a part of a very successful international collaboration we combined an experimental study of the group of Prof. Harald Brune (EPFL, Switzerland) with the computer modeling carried out by Vinca researchers, to demonstrate that single Ho adatoms at ultrathin MgO films grown on Ag(100) surface (Fig. 2) are stable magnets at temperatures up to 30 K.

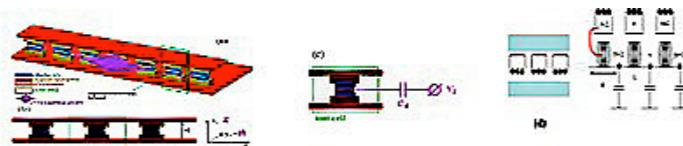
The results of the study, supported by Swiss National Science Foundation, have been published in *Science* magazine.

### QUANTUM METAMATERIALS (QMM)

Quantum metamaterials are substances built of artificial atoms or meta-atoms (MA). MA-s, as well as the natural ones, have discrete energy spectrum, but they are of mesoscopic scale and consist of large number ( $\sim 10^9$ ) of natural atoms. The main feature of MA-s, of particular interest for various applications, is controlability of their energy parameters – energy level splitting.

Arrangement of the large number of MA-s, it is possible to built QMM, roughly speaking an artificial crystals with mostly one MA in unit cell. There a few types of QMM, and those based on superconducting devices are of particular interest.

QMMs are the base for development of new quantum technologies- quantum information and communication technologies. Our main contribution is proposal of the quantum „device“ which may significantly slow down light and sound waves, which is of interest for information storage–development of quantum memories.



Prikaz konstrukcije KMM. Na slikama a. i b. predstavljen je jednodimenzionalni "kristal" građen od velikog broja tzv. "ČARDŽ" kubitova sa jednim MA-om po elementarnoj ćeliji - slika c. Na slici d. predstavljen je sličan uređaj, ali sa jednim FLUKS kubitom po elementarnoj ćeliji. U oba slučaja MA-i su vezani (Džozefsonovim spojevima u prvom slučaju, ili induktivno u drugom) sa masivnim superprovodnim rezonatorom sa čijim EM-modovima interaguju.

*Presentation of the construction of QMM with EM radiation passing through it. In Figures a. And b. One-dimensional crystal composed of large number of MA-s, Charge qubits with single qubit in unit cell. In Fig. d similar device is presented, but with flux qubits instead of charge ones. In both cases qubits are connected with massive superconducting resonator and interacts with its EM-normal modes.*

### Self-induced transparency of the optical phonons, A. Mandilara, Z. Ivić, D. Čevizović, Chaos, Solitons and Fractals, 105, pp. 14-20, 2017

Ivić, Z., Lazarides, N., Tsironis, G.P., *Qubit lattice coherence induced by electromagnetic pulses in superconducting metamaterials.*

### JAKO KORELISANI ELEKTRONSKI SISTEMI

Oksidi prelaznih metala predstavljaju posebno interesantno područje istraživanja koje je do sada dovelo do otkrića superprovodnika na visokim temperaturama, materijala sa kolosalnom magnetootpornošću i do novih ferroelektričnih i magnetoelektričnih materijala. Ovi materijali objedinjavaju kompleksne fizičke osobine koje su međusobno povezane i koje u mnogim slučajevima nisu u potpunosti rastumačene. Bogatstvo u mogućnostima konačnih ishoda ovih interakcija pruža plodno tlo za kreiranje željenih osobina materijala.

U okviru ovog projekta, glavna pažnja je usmerena ka perovskitim jedinjenjima rutenata u formi monokristala i polikristala. CaRuO<sub>3</sub> i SrRuO<sub>3</sub> su metalični oksidi kod kojih Ru ion sadrži četiri elektrona u d-orbitali i ima ukupni magnetni moment S=1 zahvaljujući nisko-spinskoj konfiguraciji. Iako postoje veoma mala razlika u parametrima kristalne rešetke ovih jedinjenja, CaRuO<sub>3</sub> nema magnetno uređenje do najnižih temperatura, dok je SrRuO<sub>3</sub> zrinski feromagnetični sa Kirijevom temperaturom od 165K. Nemagnetne supstitucije na mestu Ru kod CaRuO<sub>3</sub>, dovode do neočekivanih magnetnih osnovnih stanja, koja nije moguće interpretirati konvencionalnim teorijskim modelima. Kao rezultat planiranih aktivnosti očekujemo da pored razumevanja ovih kompleksnih i interesantnih fenomena dođemo i do saznanja koja mogu pomoći u dizajniranju novih veštačkih struktura i sa njima do novih uređaja.

### STRONGLY CORRELATED ELECTRON SYSTEMS

Transition metal oxides present particularly promising research field, which has already delivered materials like high-temperature superconductors, colossal magnetoresistive materials, and the new ferroelectric and magnetoelectric materials. These materials comprise complex physical properties which are mutually linked, and in many cases are not well understood. The rich variety of possible outcomes of these interactions provides a fertile ground to engineer the desired properties of materials.

Within this project, the main focus is primarily on the perovskites ruthenates in a single crystal and polycrystalline forms. CaRuO<sub>3</sub> and SrRuO<sub>3</sub> are metallic oxides with four electrons in d-shell on Ru ion, and total magnetic moment S=1, due to the low spin configuration. Although there is a very small difference in crystal structure parameters of CaRuO<sub>3</sub> and SrRuO<sub>3</sub>, the former shows no sign of long-range magnetic ordering at any temperature, whereas the latter is band ferromagnetic with Curie temperature of 165K. Non-magnetic substitutions for Ru in CaRuO<sub>3</sub>, trigger unexpected magnetic ground states which defy conventional theoretical interpretation. As the outcome of the planned activities, besides gaining a deeper scientific understanding of these complex and intriguing phenomena, we expect to provide clues in designing the new artificial structures leading to novel devices.

### MAGNETIC AND RADIONUCLIDE LABELED NANOSTRUCTURED MATERIALS FOR MEDICAL APPLICATIONS

This is a modern problem that encompasses a wide range of research on magnetic nanoparticles with properties suitable for biomedical applications. Their application is based on the ability to be manipulated by external magnetic field, and the ability to release heat (so-called magnetic hyperthermia). With the addition of certain radionuclides either as markers or active agents, these systems can, under certain conditions, be used as an additional measure in cancer therapy. In the past two years, significant progress has been made in the design of magnetic nanoparticles, which are suitable for both magnetic hyperthermia and radio-labeling. High radio-labeling rates with 90Y, even more than 97%, have been achieved. The examination of the influence of external magnetic field on the localization of magnetic nanoparticles in mice (in the tail region) has shown a significant effect. A great support for this research program comes also through the realization of two international projects: NANORADIOMAG project within the EUREKA program dedicated to nanoparticle synthesis and design, and the European FP7 project MAGBIOVIN, which provides material and personnel support in the form of the purchase of state-of-the-art equipment and the employment of researchers with extensive experience in the scientific field.

GRUPA ZA HEMIJSKU KRISTALOGRAFIJU

Ova četvorčlana grupa istraživača u poslednje dve godine je bila usmerena na istraživanje nekovalentnih interakcija, strukturnih i konformacionih osobina različitih molekula u kristalnom stanju. Istraživači iz grupe za hemijsku kristalografsku publikovali su u predhodne dve godine više od 20 radova iz oblasti kristalografske i različitih grana hemije. Mnogi od ostvarenih rezultata su značajni zbog svoje potencijalne primene u dizajnu novih materijala i jedinjenja sa kovalentnim vezama. Istraživači iz ove grupe koriste eksperimente difrakcije rendgenskog zračenja sa monokristala, kembričku bazu kristalografskih podataka kao i različite računarske metode.

Posebna pažnja poslednjih godina posvećena je analizi raspodele elektronske gustine u molekulima koja je bazirana na eksperimentima visoke rezolucije koji se ostvaruju difrakcijom rendgenskog zračenja na niskim temperaturama. Dalji napredak grupe u ovoj najsofisticiranijoj kristalografskoj oblasti verifikovan je preko nekoliko najnovijih publikacija.

## LIČNOST, MENTALNI POREMEĆAJI I NJIHOVI BIOLOŠKI KORELATI

Ova problematika je deo multidisciplinarnih istraživanja započetih u okviru EU FP6 projekta "*Psihobiologija posttraumatskog stresnog poremećaja*". Aktuelno je traženje biomarkera mentalnih oboljenja sa krajnjim ciljem poboljšanja dijagnostike i terapije. Poslednjih godina se sve više shvata da su osobine ličnosti predispozicije za ove bolesti, tj. da postoji kontinuum, gde je bolest ekstrem na osi osobine. Naša istraživanja pokazuju da su osobine ličnosti dobri prediktori mentalnih poremećaja indukovanih stresom i da su direktnije vezane za merene neurohormone nego simptomi bolesti.

## Nalazi i planovi

1. Nađeno da su dva neurohormona – kortizol i dehidroepiandrosteron sulfat – u direktnoj korelaciji sa nekim osobinama ličnosti, a ove sa simptomima posttraumatskog poremećaja (PTSP) i depresije
  2. Istraživanjem na oko 4500 ispitanika je ustanovljena osobina ličnosti nazvana 'dezintegracija', koja je faktor rizika za psihoze (šizofreniju), ali i za druge mentalne bolesti
  3. U toku je analiza podataka nekih signalnih puteva kod zdravih i pacijenata sa PTSP
  4. Planira se genotipizacija, tj. ispitivanje polimorfizama osobine ličnosti 'dezintegracije'.
  1. Two neurohormones – cortisol and dehydroepiandrosterone sulphate – are in direct correlation with some personality traits, and the latter are related to posttraumatic disorder (PTSD) and depressive symptoms.
  2. In a research on 4500 subjects, a personality trait named *Disintegration* was established. It is a risk factor for psychoses (schizophrenia), but also for other mental illnesses.
  3. Data analysis of some signaling pathways in health and PTSD are under way.
  4. Polymorphism genotyping of *Disintegration* is planned.

**Osobine ličnosti imaju biološke korelate i dobri su prediktori mentalnih poremećaja**

**Personality traits have biological underpinnings and they are good predictors of mental disorders**

## CHEMICAL CRYSTALLOGRAPHY GROUP

This four-membered research group has been mainly focused in last two years on the studies of non-covalent interactions, structural and conformation properties of different molecules in crystal state. Researchers from the Chemical Crystallography Group published in previous two years more than 20 papers in the field of crystallography and different area of chemistry. Many of results have significance and potential application in crystal engineering and design of new materials and active covalent compounds. The researchers in their investigations use single-crystal X-ray diffraction analysis, Cambridge Structural Database and different computational methods.

Particular attention in the past years was dedicated to the research area of experimental charge density analysis based on high-resolution X-ray diffraction experiments at low temperatures. Further progress of the group in this sophisticated crystallographic method are validated by several recent publications.

## **PERSONALITY, MENTAL DISORDERS AND THEIR BIOLOGICAL CORRELATIVES**

This topic is a part of the multidisciplinary research initiated within an EU FP6 project "*Psychobiology of the posttraumatic stress disorder*". We are seeking biomarkers of mental disorders, aimed at improving diagnostics and therapy. It is becoming increasingly clear that personality traits are predispositions for these diseases, i.e. that there is a continuum, in which the disease is the extreme of the trait axis. Our investigations show that the personality traits are good predictors of the stress-induced mental disorders and that they are more related to neurohormones than the symptoms.

## Findings and plans

1. Two neurohormones – cortisol and dehydroepiandrosterone sulphate – are in direct correlation with some personality traits, and the latter are related to posttraumatic disorder (PTSD) and depressive symptoms.
  2. In a research on 4500 subjects, a personality trait named *Disintegration* was established. It is a risk factor for psychoses (schizophrenia), but also for other mental illnesses.
  3. Data analysis of some signaling pathways in health and PTSD are under way.
  4. Polymorphism genotyping of *Disintegration* is planned.

# LABORATORIJA ZA RADIJACIONU HEMIJU I FIZIKU «GAMA»

# DEPARTMENT OF RADIATION CHEMISTRY AND PHYSICS

O NAMA

## ABOUT US

Laboratorija za radijacionu hemiju i fiziku "Gama" je najveća Laboratorija u Institutu "Vinča" u kojoj radi 75 stalno zaposlenih, od kojih je 58 istraživača prosečne starosti od 41 godinu. Posvećena je osnovnim i primjenjenim istraživanjima u oblasti hemije i fizike materijala, kao i pružanjem komercijalnih usluga i transferu znanja industriji (50 kompanija pod komercijalnim ugovorima) i javnim zdravstvenim organizacijama. Laboratorija ostvaruje intenzivnu međunarodnu saradnju sa oko 20 vodećih naučnih centara u inostranstvu, ima dugu i sadržajnu saradnju sa **MAAE** i učestvuje u organizaciji međunarodnih naučnih skupova.

Naučna istraživanja su fokusirana na razvoj i primene svih tipova nanočestica (ugljenične, luminescentne, poluprovodničke i plazmonske), kao i na korišćenje izvora zračenja (visoko-energetsko, lasersko) za procesiranje materijala. Ostvareni naučni rezultati se mogu okarakterisati kao visoko-kvalitetni, primenljivi i publikativni (ostvareno je 1,5 međunarodnih publikacija po istraživaču godišnje, što je oko 4 puta više od proseka koji ostvaruje srpska naučna zajednica). Saradnja sa privredom se realizovala kroz uslužnu sterilizaciju medicinskog pribora i sredstava, kao i konzervaciju hrane sa godišnjim prometom od oko 32 miliona dinara.

<https://www.gammalab.org/>

ISTAKNUTO U 2016-2017

MAAE Regionalni trening kurs

Regionalni trening kurs o bezbednom radu gama i akceleratorskih postrojenja za ozračivanje pod nazivom „*Using Advanced Radiation Technologies for Materials Processing, Regional Training Course on Safe Operation of Gamma and E-beam Facilities for Radiation Processing*“ održan je u Beogradu, u periodu od 26. do 30.06.2017. u saradnji Laboratorije za radijacionu hemiju i fiziku „Gama“ Instituta za nuklearne nauke „Vinča“ i Međunarodne agencije za atomsku energiju (IAEA).

Cilj ovog trening kursa bio je poboljšanje i razmena znanja i iskustava o trenutnom pristupu bezbednom radu u gama i akceleratorskim postrojenjima za ozračivanje. Učešnicima kursa je predstavljeno funkcionsanje Radijacione jedinice za industrijsku sterilizaciju i konzervaciju, dozimetrijska kontrola apsorbovane doze zračenja, kontrola procesa, mere bezbednosti, sigurnosna pravila, održavanje, provjera i kontrola postrojenja. Na regionalnom trening kursu prisustvovalo je 20 učešnika iz zemlje i inostranstva.

Laboratory for Radiation Chemistry and Physics "Gamma" is the largest Department in Vinča Institute with 75 permanent employees, 58 of which are researchers (of an average age of 41). It is devoted to fundamental and applied research in the field of materials chemistry and physics, and for providing services and know-how to industry (50 contractor companies) and organizations of public health. Laboratory has strong international collaboration with about 20 leading scientific centers abroad, long and close cooperation with IAEA, and it is involved in organizing international scientific conferences.

Research is focused on the development and applications of all types on nanoparticles (carbon, phosphor, quantum dots, and plasmonic), and the use of radiation sources (high-energy gamma, lasers) for materials processing. Research results are characterized by its high-quality, applicability and publishability, with about 1.5 international publication per researcher per year (which is about 4 times higher than the average in Serbian science). Industry cooperation is mainly realized by providing radiation sterilization of medical devices and food conservation with an annual turnover of about 32 million dinars.

<https://www.gammalab.org/>

## 2016-2017 HIGHLIGHTS

IAEA Regional Training Course

The regional training course on safe operation of Gamma and E-beam irradiation facilities named "*Using Advanced Radiation Technologies for Materials Processing, Regional Training Course on Safe Operation of Gamma and E-beam Facilities for Radiation Processing*" was held in Belgrade, 26.06.2017 until 30.06.2017. in cooperation with the Laboratory for Radiation Chemistry and Physics "Gamma" in the Institute of Nuclear Sciences "Vinča" and the International Atomic Energy Agency (**IAEA**).

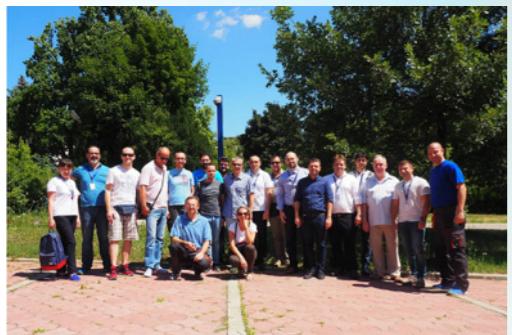
The purpose of the training course was to enhance and exchange knowledge and experience on recent approaches for safe operation of gamma and e-beam facilities for radiation processing. Operations of the Radiation Unit for industrial sterilization and conservation, dosimetric control of the absorbed dose, process control, safety measures, safety rules, maintenance, checks and controls of the facility were presented to the participants. The regional training course was attended by 20 participants from the Republic of Serbia and abroad.

U junu 2015. godine, Laboratorijska za radijacionu hemiju i fiziku "Gamma" je implementirala ISO 9001:2008 Sistem menadžmenta kvalitetom.

U 2016-2017 Laboratorijska "Gama" je radila na prelazu na novu verziju standarda ISO 9001:2015 i uvođenju ISO 13485:2016 standarda (za medicinska sredstva) u skladu sa ISO 11137 standardima (Sterilizacija medicinskih proizvoda).

In June 2015 Laboratory for Radiation Chemistry and Physics "Gamma" has implemented ISO 9001:2008 Quality management system.

In 2016-2017 Laboratory "Gamma" worked towards the transition to the new standard version ISO 9001:2015 and the introduction of ISO 13485:2016 standard (for medical devices) in accordance with a series of ISO 11137 standards (Sterilization of health care products).



Učesnici regionalnog trening kursa o bezbednom radu gama i akceleratorskih postrojenja za ozračivanje,  
26. do 30.06.2017.  
Institut za nuklearne nauke „Vinča“

Participants of the regional training course on safe operation of Gamma and E-beam irradiation,  
26-30 June 2017.  
Institute for Nuclear Sciences "Vinča"

#### Konzervacija kožnih rukavica Nikole Tesle

Osim aktivnosti na industrijskoj sterilizaciji i konzervaciji hrane Laboratorijska "Gama" je angažovana na zaštiti kulturnih dobara. U 2017. godini, zajedno sa saradnicima Muzeja "Nikola Tesla", obavljena je konzervacija velikog broja kožnih rukavica koje je koristio naš čuveni naučnik Nikola Tesla. Doza gama zračenja koja je primenjena na rukavice određena je nakon detaljne mikrobiološke i strukturne analize uzoraka rukavica.

Ovi značajni izložbeni eksponati su danas ponovo dostupni svim posetiocima muzeja.

Kožne rukavice Nikole Tesle pre (slika gore) i posle (slika dole) konzervacije gama zračenjem.  
(rukavice su vlasništvo Muzeja Nikole Tesle iz Beograda).

Nikola Tesla leather gloves before (upper image) and after (bottom image) conservation by gamma-irradiation (gloves are property of the Museum of Nikola Tesla, Belgrade)



# LABORATORIJA ZA FIZIČKU HEMIJU DEPARTMENT OF PHYSICAL CHEMISTRY

## O LABORATORIJI

Laboratorijska za fizičku hemiju je tokom 2016/2017. godine održala status jedne od vodećih naučno-istraživačkih laboratorijskih u Institutu za nuklearne nauke „Vinča“.

U Laboratorijski se neguje multidisciplinarni pristup osnovnim i primenjenim istraživanjima, a razvijaju se i unapređuju delatnosti koje osiguravaju sticanje znanja i veština primerenih izazovima savremenog društva.

Realizovane su planirane aktivnosti u okviru nacionalnih i međunarodnih naučnih i tehnoloških projekata, kao i postavljeni ciljevi u obrazovno – razvojnom radu i komercijalnoj delatnosti.

Nesmetano odvijanje glavnih procesa u Laboratorijski postiže se sistemom upravljanja kvalitetom u skladu sa zahtevima standarda ISO 9001.

## ABOUT THE DEPARTMENT

During the 2016/2017, Department of Physical Chemistry held the status of one of the leading laboratories of Vinča Institute.

We foster the multidisciplinary approach to basic and applied research, and develop and improve activities that ensure the acquisition of knowledge and skills appropriate to the challenges of contemporary society.

The activities planned within the national and international scientific research and development projects are executed and the goals set in educational and commercial work are achieved.

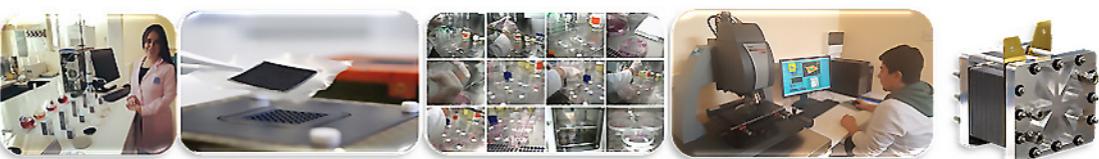
Securing the main process in the Department is achieved by the implemented quality management system in accordance with the ISO 9001 standard.

## THE MISSION

- Transfer znanja kroz istraživanja i plasman proizvoda prosteklih iz njih;
- Razvoj novih metoda ispitivanja i naprednih tehnologija;
- Obrazovanje kompetentnih stručnjaka, koji će uspešno, etički i moralno odgovarati na savremene izazove, podizajući ukupan kvalitet naučno-istraživačkog rada u lokalnom, nacionalnom i međunarodnom okruženju.
- Knowledge transfer through research and placement of products developed from research;
- Development of new testing methods and advanced technologies;
- Education of competent experts, which will successfully, ethically and morally respond to contemporary challenges, raising the overall quality of scientific research in the local, national and international environment.

Objavljeno je preko 100 radova u istaknutim međunarodnim naučnim časopisima u periodu 2016/2017. Publikovani su rezultati iz oblasti zaštite životne sredine, vodonične energije, analitičke hemije, bioanalitike i toksikologije, laserske spektroskopije i proučavanja radioprotективnih efekata biološki aktivnih jedinjenja lekovitog bilja.

More than a hundred scientific papers have been published in prominent international scientific journals in the period 2016/2017. Our research areas are environmental protection, hydrogen energy, analytical chemistry, bioanalytics and toxicology, laser spectroscopy and the study of radioprotective effects of biologically active compounds of medicinal herbs were published.



Nasi istraživači objavljaju rezultate u istaknutim međunarodnim naučnim časopisima, prema podacima svetskih indeksnih baza.

*Papers published by the researches of the Department of Physical Chemistry are in the highest categories of the world index bases.*

## NAJVREDNIJI RESURSI **Obrazovani i motivisani zaposleni**

Tokom poslednje dve godine, Laboratorija je postala bogatija za 8 mladih i perspektivnih doktora nauka.

### Akreditacija

Početkom 2016. godine, Laboratorija za fizičku hemiju je akreditovana prema zahtevima standarda ISO/IEC 17025 za ispitivanje građevinskih materijala, otpada, zemljišta i otpadne vode.

Proširena je akreditacija Kotrolnog tела za proizvode i procese, akreditovanog prema standardu ISO 17020.

Od početka akreditacije Laboratorije, ispitivano je preko 2000 uzoraka.

## PONOSNI SMO NA: **Međunarodna saradnja**

Započeli smo projekat sa Međunarodnom agencijom za atomsku energiju (IAEA) pod nazivom: *Behaviour of ICF Reactor Materials under High Temperatures and High Energy Fluxes Obtained by Medium/High-Intensity Pulsed Lasers*.

Realizovan je eksperimentalni deo projekta "Prevencija nastajanja lezija sluzokoz usta uzrokovanih dejstvom duvana" finansiran od strane švedske kompanije *Swedish Match*.

U 2016. godini potpisani su Memorandum o zajedničkoj realizaciji Master i Doktorskih studija sa Univerzitetom Tor Vergata u Rimu, iz oblasti hemijske zaštite.

### Ističemo doprinos u rešavanju problema zajednice

Poslednjih nekoliko godina, Laboratorija je naročito aktivna u rešavanju ekoloških problema na teritoriji RS. Sprovedeni su brojni postupci detekcije i dekontaminacije zagađenja nastalih kroz različite hemijske incidente. U saradnji sa drugim državnim organima, učestvujemo u rešavanju problema ne-propisnog odlaganja hemijskog otpada.

### Saradnja sa industrijom

U saradnji sa Traval Korporacijom A.D. Kruševac, pokrenut je projekat izrade, instalacije, puštanja u rad i dokazivanja performansi opreme (ispitni sistem VINFIL TEST STATION) za ispitivanje zaštitnih moći filtera za gas maske korišćenjem 16 test gasova.

## MOST VALUABLE RESOURCES **Educated and motivated staff**

Over the past two years, our research staff was reinforced by 8 young and promising PhDs.

### Accreditation

At the beginning of the 2016., Department of Physical Chemistry was accredited according to the requirements of ISO / IEC 17025 for the testing of building materials, waste, land, and wastewater.

Accreditation of the Inspection Body for products and processes accredited to the ISO 17020 standard has been extended.

Since the beginning of accreditation, over two thousand laboratory tests have been performed.

## WE ARE PROUD OF: **International cooperation**

We have started a project with the International Atomic Energy Agency (IAEA): *Behaviour of ICF Reactor Materials under High Temperatures and High Energy Fluxes Obtained by Medium / High-Intensity Pulsed Lasers*.

The experimental part of the project "Prevention of mucosal lesion mucous membrane lesions" was funded by the Swedish company Swedish Match.

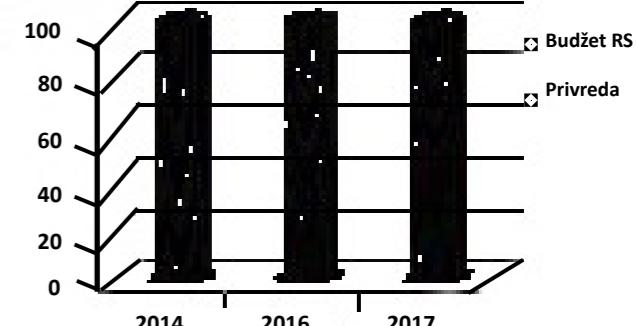
In 2016 we signed a Memorandum on joint realization of Master and Doctoral Studies with the University of Rome, Tor Vergata, in the field of chemical protection.

### Contribution to solving the community problems

During 2016 – 2017, the decontamination of residential building 3, entrance A, at Mileve Marić Einstein Street in Belgrade has been completed (Client: Construction Directorate of Serbia doo), as well as the decontamination of the Bora Stanković Theater building in Vranje (Client: Vranje city).

### Collaboration with industry

A cooperation with Traval Corporation A.D. Kruševac has been established through the project of development, installation implementation and performance testing of equipment for investigation of gas-masks protection capacities for 16 test gases (VINFIL TEST STATION).



## We offer innovative products and services **Production and development**

The Department's researches are constantly working on development, improvement, and market placement of various technical solutions and products, such as a purifying filter for drinking water, cabinets for chemicals, high capacity ozonizers, protective fabrics for toxic chemicals, chambers for sampling of volatile and semivolatile compounds in ambient air, etc.

## Ponuda inovativnih proizvoda i usluga **Proizvodno-razvojna delatnost**

U Laboratoriji se konstantno radi na razvoju, usavršavanju i tržišnom plasmanu različitih tehničkih rešenja i proizvoda, poput filtera za prečišćavanje vode za piće, ormara za baze i kiseline, ozonizatora velikog kapaciteta, zaštitnih tkanina za toksične hemikalije, komora za ispitivanje emisije poluisparljivih i isparljivih jedinjenja u ambijentalni vazduh itd.

### Laboratorijska ispitivanja

Pružamo usluge laboratorijskih ispitivanja građevinskih materijala, uzoraka životne sredine, ambalaže, uzoraka nepoznatog porekla, emisije organskih jedinjenja, učestalosti hromozomskeih aberacija i mikronucleus test.

U toku protekle godine urađeno je preko dve hiljade laboratorijskih ispitivanja.

### Laboratory Testings

We provide laboratory testings of construction materials, environmental samples, packings, emission of organic compounds, physico-chemical analysis of unknown samples, chromosome aberrations and micronucleus tests.

During the past two years our lab analysts conducted over two thousand tests.

### Transfer znanja

Laboratorija za fizičku hemiju pruža usluge testiranja i obuka u oblasti detekcije, dekontaminacije i zaštite od industrijskih toksičnih hemikalija. Ova oblast dobija na važnosti u svetu događaju koju ugrožavaju život i zdravlje stanovništva. S obzirom da je prepoznata potreba širenja akumuliranog znanja i iskustva, u toku 2016. god. formirana je kompletna infrastruktura za pružanje usluge edukacija u ovoj oblasti – učionice, laboratorije i platforma za praktičnu obuku.

Obuke različitih scenarija i nivoa (osnovni, srednji i napredni) mogu se osmisli i sproveсти prema potrebama klijenata.

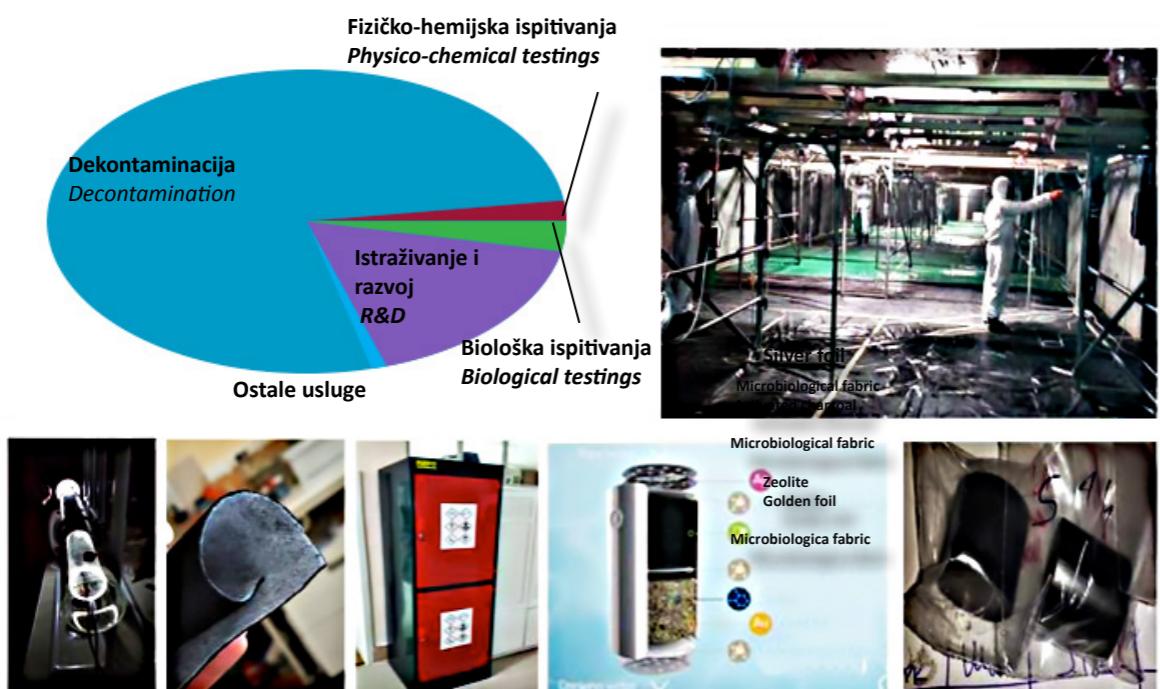
### Knowledge Transfer

Department of Physical Chemistry provides testing and training in the field of detection, decontamination, and protection against toxic chemicals. This field is gaining significance due to the increasing number of events involving the use of toxic chemicals, which endanger life and health. During 2016, a complete infrastructure was developed for this purpose- classrooms, laboratories and an outdoor training platform.

Various training scenarios for a range of professional levels (basic, intermediate, and advanced) can be designed and implemented, tailored to clients' needs.

Ponuda inovativnih proizvoda i usluga iz znanja stečenih u istraživanjima

We offer innovative products and services using knowledge gained through research



#### Ulaganje u najsvremeniju istraživačku opremu

Prihodi od tržišnih aktivnosti se stalno koriste za ulaganja u najsvremeniju istraživačku i ispitnu opremu.

U periodu 2016/2017 godine nabavljeni su sledeći najnoviji modeli za fizičko-hemiju i biološku ispitivanja: Gasni hromatograf 7890B GC sa masenim detektorom 5977B MSD (Agilent technologies) i termalnim desorberom UNITY-xr (Market), ICP spektrometar iCAP 7000 series (Thermo Electron Corporation), ion chromatograph, FTIR, TOC-VCPN analizator, jonski hromatograf, FTIR, TOC-VCPN analizator, mikrotalasni digestor, GAMRI potenciometri/potencijostati, prenosi XRD analizator.

#### Investments in the up-to-date research equipment

We constantly use the income from our services to invest into new research and testing equipment. During 2016/2017 the following latest models were bought for physico-chemical and biological analyses: Gas chromatograph 7890B GC with a mass detector 5977B MSD (Agilent technologies) and thermal desorber UNITY-xr (Market), ICP spectrometer iCAP 7000 series (Thermo Electron Corporation), ion chromatograph, FTIR, TOC-VCPN analyser, microwave digestor, GAMRI potentiometers/potentiostats, portable XRF analyser.

# LABORATORIJA ZA HEMIJSKU DINAMIKU I PERMANENTNO OBRAZOVANJE

## DEPARTMENT OF CHEMICAL DYNAMICS AND PERMANENT EDUCATION

### O N A M A

Laboratorijska grupa za hemijsku dinamiku i permanentno obrazovanje je jedinstvena Laboratorijska grupa u Institutu za nuklearne nauke „Vinča“ koja u potpunosti oslikava svu multidisciplinarnost instituta. Saradnici Laboratorijske grupe su uključeni u naučna istraživanja u oblastima zaštite životne sredine, proučavanja procesa ionske izmene i adsorpcije, termodinamike i termohemije, sinteze i karakterizacije neorganskih materijala, analitičke hemije i spektrohemije, radioekologije i ispitivanja predmeta kulturnog nasledja kroz brojne nacionalne i međunarodne projekte (IAEA, COST, bilateralni i dr.). Kao rezultat toga su objavljeni brojni naučni i stručni radovi u referentnim međunarodnim časopisima, a deo njih je prezentovan i na međunarodnim i nacionalnim konferencijama.

Pored toga, Laboratorijska grupa već dugi niz godina uspešno ostvaruje saradnju sa brojnim privrednim institucijama i drugim ustanovama pružajući raznovrsnu paletu usluga fizičko-hemiskih i radiometrijskih ispitivanja kroz akreditovanu Laboratorijsku grupu u skladu sa međunarodnim standardom SRPS ISO/IEC 17025:2006. Lista institucija koje koriste naše usluge radiometrijskih, uglavnom gammasekrometrijskih ispitivanja je brojna pa ćemo spomenuti samo one najvažnije, kao što su Institut za higijenu i tehnologiju mesa Beograd, „Gradski zavod za javno zdravlje“ Beograd, „Zavod za javno zdravlje“ Šabac, Eurosped, Agent servis, Institut MOL, „Institut za javno zdravlje“ Kragujevac i brojni drugi. Ostvarena je saradnja sa brojnim privrednim subjektima u oblasti tretmana otpadnih voda (Alumil, Henkel, Froneri Adriatic, Delta inženjer, JP EPS,...) pa su naši saradnici bili uključeni u procese analize efikasnosti postupaka prerade i njihovu implementaciju na terenu. Jedina smo laboratorijska grupa koja je opremlila i akreditovala izdvojenu laboratorijsku za gammasekrometrijsku merenje na lokaciji korisnika ispitivanja, kako bi se optimizovao i zaštitio transport uzorka za analize. Jedinstveni smo i po tome što smo jedina Laboratorijska grupa u zemljama koja pruža uslugu neinvazivnih i nedestruktivnih ispitivanja predmeta kulturnog nasledja na lokacijama na kojima se ti predmeti nalaze korišćenjem prenosa opreme što je potvrđeno uspešnom saradnjom sa skoro svim ustanovama kulture u zemljama i brojnim analizama umetničkih slika naših poznatih umetnika (Petar Lubarda, Sava Šumanović, Nadežda Petrović, Katarina Ivanović i dr.) i ikona i fresaka nemerljive vrednosti.

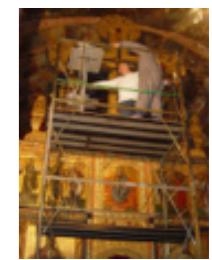
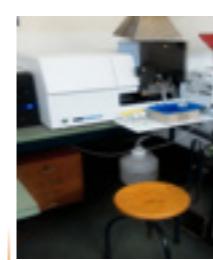
Specifičnost Laboratorijske grupe potvrđuje i njen odeljenje „Škola računara“, najstarija i najpoznatija institucija uvek u zemljama tradicijom koja datira još iz vremena 1980-ih i početnih razvoja IT oblasti. Od tada pa do danas, kroz školu je uspešno prošlo više od 40 000 polaznika iz različitih oblasti IT i ostvarena je uspešna saradnja sa preko 500 kompanijama iz različitih oblasti poslovanja. „Škola računara“ Instituta Vinča je aktivni član Microsoft mreže partnera i AUTODESK autorizovan trening centar.

### A B O U T U S

Department of Chemical Dynamics and Permanent Education 060 is a unique department at VINČA Institute of Nuclear Sciences and completely represents the whole multidisciplinary of the Institute itself. Researchers from this Department are involved in different science projects in the field of the environmental protection, ion exchange and adsorption, thermodynamics and thermochemistry, synthesis and characterization of the various inorganic materials, analytical chemistry and spectrochemistry, radioecology and characterization of the cultural heritage objects and funded by national and international institutions (IAEA, COST, bilateral projects etc.). As a result of their work, numerous scientific papers are published in the international peer reviewed journals and presented on the national and international conferences.

Beside this scientific work, Department established fruitful cooperation with numerous companies and institutions thus providing services of various physicochemical and radiometric testing of different goods and samples in the scope of the accredited laboratory according to international SRPS ISO/IEC 17025:2006 standard. Reference list of companies which are users of our radiometric mainly gamma-spectrometry services is long so we would like to mention those which are more important for us like Institute of meat hygiene and technology Belgrade, Public health institutions from Belgrade, Sabac and Kragujevac, Europsed, Agent Servis, MOL Institute etc. Cooperation with companies from different business areas is established on the projects regarding waste water treatment (Alumil, Henkel, Froneri Adriatic, Delta Inženjer, JP EPS ETC.) and our staff were involved in processes of investigations of the efficiencies of waste water treatment facilities on the numerous sites. Our laboratory is also providing unique service of gamma-spectrometry testing in the premises of the users since we managed to equip and accredit laboratory on the site outside our Institute with aim to optimize and preserve sample chain. We are also provider of specific service of non-invasive and non-destructive investigation of cultural heritage objects on their original position and status which is confirmed with succesful cooperation with almost all national institutions involved in cultural heritage conservation and preservation and followed with results of analysis of paintings of Serbian famous artists, icons and frescoes of priceless value.

Another unique characteristic of our Department is our IT division for education in the field of computer and IT applications, the oldest and most famous institution of this type in Serbia with tradition which originates from 1980s and “dawn” of the IT era. Since then more than 40 000 students were educated and certified for various IT skills alongside with succesful cooperation with more than 500 companies from different business fields in the framework of the Microsoft network and authorized AUTODESK training center.



## ZNAČAJNI TRENUCI 2016-2017

U toku 2016-2017 Laboratorija je postala "bogatija" za pet novih doktora nauka čime se njihov broj povećao na 13 što je skoro polovina saradnika Laboratorije.

Naučna istraživanja se uspešno realizuju u okviru nacionalnih projekata kao i međunarodnih projekata kao što su:

- Atmospheric Electricity Network: Coupling with the Earth System, Climate and Biological Systems" (ELECTRONET), COST Action CA15211, 2016-2020, rukovodilac tima INNV dr Snežana Dragović, naučni savetnik
- COST-European Cooperation in Science and Technology, to the Cost Action ES1403: New and Emerging challenges and opportunities in wastewater reuse (NEREUS), 2014-2018, član radne grupe (Working group V - Risk assessment and policy development) dr Maja Đolić, naučni saradnik
- COST akcija COST Action CA15114 COST Association: Anti-Microbial Coating Innovations to prevent infectious diseases (AMICI), 2016-2020, rukovodilac tima INNV dr Aleksandra Nešić, naučni saradnik

## Akreditacija i ovlašćenja

Početkom 2017. godine, Laboratorija je obnovila akreditaciju po standardu SRPS ISO/IEC 17025:2006 za naredni četvorogodišnji period uz uvođenje novih metoda fizičkohemijskih ispitivanja svih vrsta voda i na taj način potvrdila kompetenciju svojih saradnika i kvalitet merne opreme i korišćenih metoda ispitivanja.

Takođe su obnovljene licence neophodne za obavljanje poslova fizičkohemijskih i radiometrijskih ispitivanja koje su izdale odgovarajuće državne ustanove (Ministarstvo poljoprivrede i zaštite životne sredine i Agencija za zaštitu od ionizujućih zračenja i nuklearnu sigurnost Srbije).

Kvalitet obrazovnih programa "škole računara" Instituta Vinča je prepoznao i Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije koje je sertifikovalo dva najpopularnija IT programa "Obuka za programiranje aplikacija" i "Obuka za programiranje WEB aplikacija" kao i program "Obavljanje poslova zaštite i bezbednosti informacija" i na taj način "Školu računara" Instituta Vinča priznalo kao Javno priznatog organizatora aktivnosti obrazovanja (JPOA).

## Usluge laboratorijskih ispitivanja i konsultantskih usluga

Laboratorija može da pruži usluge fizičkohemijskih ispitivanja neorganskih i određenih organskih parametara u uzorcima voda različitog porekla, kao i različitim vrstama drugih materijala.

Takođe vršimo nedestruktivna ispitivanja i elementarnu analizu svih vrsta predmeta i uzoraka uključujući i predmete kulturnog nasleđa kod kojih možemo analizirati pigmente i veziva na bojenim slojevima kao i elementarnu analizu arheoloških predmeta.

Za ispitivanja koristimo savremenu opremu i tehnike i metode ispitivanja (ICP-MS-HPLC, IC, GFAAS, ICP-OES, FAAS, EDXRF, FTIR, GRS, UV-VIS, DLS etc.)

Svoje znanje saradnici Laboratorije implementiraju kroz saradnju sa privrednim subjektima zainteresovanim za razvoj i unapređenje procesa i tehnologija prerade odnosno prečišćavanja otpadnih voda.

## HIGHLIGHTS 2016-2017

During 2016-2017, our Department was reinforced by 5 new PhDs resulting in final 13 PhD researchers which is almost a half of the people employed.

Research is realized in the scope of the nationally funded projects as well as international:

- Atmospheric Electricity Network: Coupling with the Earth System, Climate and Biological Systems" (ELECTRONET), COST Action CA15211, 2016-2020, Team Leader INSV dr Snežana Dragović, Principal Research Fellow
- COST-European Cooperation in Science and Technology, to the Cost Action ES1403: New and Emerging challenges and opportunities in wastewater reuse (NEREUS), 2014-2018, the member of Working group V - Risk assessment and policy development, dr Maja Đolić, Research Associate.
- COST Action CA15114 COST Association: Anti-Microbial Coating Innovations to prevent infectious diseases (AMICI), 2016-2020, Team Leader INSV dr Aleksandra Nesic, Research Associate.

## Accreditation

At the beginning of 2017, Laboratory of our Department renewed accreditation according to the requirements of SRPS ISO / IEC 17025:2016 for the next four year period with some new methods of physicochemical testing introduced and thus confirmed competence of staff and quality of equipment used.

Also appropriate licences issued by national appointed institutions were also renewed so all testing can be carried on in the next period.

Quality of educational programs in IT field was also recognized by Ministry of Education, Science and Technological Development since two most popular programs in IT sector together with programs for safety of information was also accredited.

## Services of Laboratory testing and consulting

Our department can provide services of various physicochemical determination of most of the inorganic and also some of the organic parameters in different water samples, as well as in the other types of samples.

We also perform on request non-destructive testing and elemental analysis of all types of objects including pigments, binders and composition of the cultural heritage objects. For those testing we use modern equipment and techniques and methods of testing (ICP-MS-HPLC, IC, GFAAS, ICP-OES, FAAS, EDXRF, FTIR, GRS, UV-VIS, DLS etc.)

We are also providing consultancy and knowledge transfer in the field of waste water treatment and technology.

# LABORATORIJA ZA RADIOIZOTOPE DEPARTMENT OF RADIOISOTOPES

## NACIONALNI I MEĐUNARODNI PROJEKTI: ISPITIVANJE NOVIH JEDINJENJA OBELEŽENIH RADIONUKLIDIMA ZA PRIMENU U MEDICINI

Multidisciplinarna naučnoistraživačka delatnost Laboratorije za radioizotope se odvija u oblasti hemije, farmacije, medicine i bazira se na razvoju novih jedinjenja oboleženih različitim radionuklidima za primenu u dijagnostici i terapiji.

Istraživači su uključeni u dva nacionalna projekta: „Magnetni i radionuklidima oboleženi nanostrukturni materijali za primenu u medicini“ i „Nove tehnologije za monitoring i zaštitu životnog okruženja od štetnih hemijskih supstanci i radijacionog opterećenja“ i više međunarodnih projekata: FP7-ERAChairs-PilotCall-2013, MAGBIOVIN—„Strengthening of the MagBioVin Research and Innovation Team for Development of Novel Approaches for Tumour Therapy based on Nanostructured Materials“; Joint research project between Beijing University of Technology (China) and Institute of Nuclear Sciences „Vinča“: „Design, fabrication, and application of magnetic targeting drug delivery system“ i COST ACTION TD 1402 - „Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy (RADIOMAG)“.

## NATIONAL AND INTERNATIONAL PROJECTS: STUDIES ON NEW COMPOUNDS LABELLED WITH DIFFERENT RADIONUCLIDES FOR THE MEDICAL APPLICATION

Multidisciplinary scientific research of the Laboratory for radioisotopes is carried out in the fields of chemistry, pharmacy and medicine and it is based on design of new radiolabelled compounds for diagnosis and therapy.

Researchers are included in two National projects: „Magnetic and radionuclides labelled nanostructured materials for application in medicine“ and „New technologies for monitoring and protection of the environment from harmful chemicals and radioactive contamination“ and several international projects: FP7-ERAChairs-PilotCall-2013, MAGBIOVIN—„Strengthening of the MagBioVin Research and Innovation Team for Development of Novel Approaches for Tumour Therapy based on Nanostructured Materials“; Joint research project between Beijing University of Technology (China) and Institute of Nuclear Sciences „Vinča“: „Design, fabrication, and application of magnetic targeting drug delivery system“ and the COST ACTION TD 1402 - „Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy (RADIOMAG)“.

**Laboratorija za radioizotope je jedinstven centar za razvoj, proizvodnju  
(registrovana od strane Ministarstva zdravlja RS) i kontrolu  
radiofarmaceutika (akreditovana kod ATS-a)**

**Department of radioisotopes is unique centre for  
research, production and  
quality control of radiopharmaceuticals**

Istovremenom primenom više metoda, pokušava se prevazići problem niske osjetljivosti i specifičnosti dijagnostičkih, i nedovoljne efikasnosti terapijskih, rutinski korišćenih metoda u medicini.

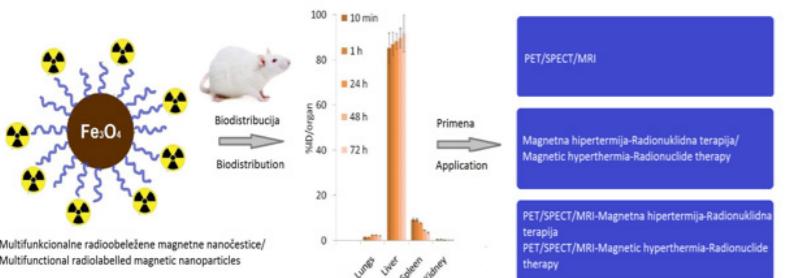
U tom cilju u Laboratoriji za radioizotope dizajnirane su, sintetisane i karakterisane multifunkcionalne magnetne nanočestice oboležene sledećim radionuklidima:

- gamma emiterom ( $^{99m}\text{Tc}$ ) za primenu u SPECT/MRI dijagnostici,
- pozitronskim emiterima  $^{64}\text{Cu}$  i  $^{68}\text{Ga}$  za PET/MRI i
- beta emiterima visokih energija  $^{90}\text{Y}$ ,  $^{177}\text{Lu}$  i  $^{131}\text{I}$  za primenu u kombinovanoj hipertermija-radionuklidnoj terapiji, uz mogućnost praćenja efekata terapije putem MRI.

Simultaneous application of several diagnostic or therapeutic methods in medicine is the way to overcome the problem of low sensitivity, specificity and efficacy of routinely used methods.

In that purpose, the Laboratory for Radioisotopes has designed, synthesized and characterized multifunctional magnetic nanoparticles labeled with the following radionuclides:

- gamma emitter ( $^{99m}\text{Tc}$ ) for SPECT/MRI imaging,
- positron emitters  $^{64}\text{Cu}$  and  $^{68}\text{Ga}$  for PET/MRI and
- beta emitters of high energies  $^{90}\text{Y}$ ,  $^{177}\text{Lu}$  i  $^{131}\text{I}$  for use in dual, combined hipertermija-radionuklidnoj terapiji, with the possibility of monitoring the effects of therapy using MRI.



### Ispitivanje multifunkcionalnih radioobeženih magnetnih nanočestica za primenu u dijagnostici i terapiji

*Studies on multifunctional radiolabeled magnetic nanoparticles for the application in diagnosis and therapy*

Efikasnost radiodijagnostičke procedure i efekat radionuklidne terapije zavise od brojnih faktora: osobina magnetnih nanočestica (veličine, površine, magnetskih osobina), osobina radionuklida (energije, dometa u tkivu, vremena poluraspa), stabilnosti radionuklidom obeženih magnetnih nanočestica, spoljnih faktora (spoljašnje magnetno polje), dok izbor odgovarajućeg radionuklida zavisi od vrste samomedicinske procedure, mesta lokalizacije, veličine i prirode retiranog tumora.

U protekle dve godine u Laboratoriji za radioizotope su razvijene metode sinteze magnetnih nanočestica obloženih novim biokompatibilnim materijalima (citrate, PEG, HSA, fosfati), optimizovani su uslovi obežavanja odgovarajućim radionuklidima, i ispitane su njihove fizičko-hemiske i biološke osobine.

Radiotraserskom metodom su određeni: in vitro (u humanom serumu) i in vivo (na Wistar pacovima) stabilnost, kao i farmakokinetički parametri radioobeženih magnetnih nanočestica za njihovu potencijalnu primenu u terapiji malignih tumora.

#### Primena radiotraserskih metoda za različita ispitivanja

Istraživači Laboratorije za radioizotope imaju saradnju sa velikim brojem Instituta i Fakulteta u zemlji i inostranstvu. Radiotraserske metode (Laboratorija za radioizotope poseduje licencu za njihovu primenu), kao veoma specifične i senzitivne, posebno se koriste za ispitivanje novih materijala i farmakokinetičke novih lekova. Ovom metodom je ispitana biodistribucija nanočestica hidroksijapatita obeženih  $^{125}\text{I}$  za primenu u regenerativnoj terapiji. Radioimmunošake tehnike su dovoljno osetljive i za određivanje niskih koncentracija hormona (tiroïdnih, steroidnih, itd.) kod životinja (saradnja na projektima Veterinarskog fakulteta).

#### PROIZVODNJA RADIOFARMACEUTIKA ZA DIJAGNOSTIKU I TERAPIJU

Laboratorija za radioizotope je tokom dugogodišnjeg naučno-istraživačkog rada i u saradnji sa nuklearno-medicinskim centrima u zemlji i inostranstvu, razvila veći broj radiofarmaceutika koji se primenjuju u dijagnostici i terapiji.

Danas je Laboratorija za radioizotope jedinstven centar na Balkanu, registrovan od strane Ministarstva zdravlja Republike Srbije, za proizvodnju radiofarmaceutika.

#### $^{99}\text{Mo}/^{99}\text{mTc}$ generator

Laboratorija za radioizotope već 35 godina proizvodi radionuklidni Univerzalni  $^{99}\text{Mo}/^{99}\text{mTc}$  generator za dobijanje  $^{99}\text{mTc}$  u obliku natrijum-pertehtnetata.

Natrijum-pertehtnetat se primenjuje za scintigrafiju štitaste žlezde, mozga, pljuvačnih žlezda, gastrointestinalnog trakta, dok se u obliku jedinjenja obeženih  $^{99}\text{mTc}$  koristi za scintigrafiju različitih organa i tkiva.

The efficacy of the radiodiagnostic procedure and the effect of radionuclide therapy depend on many factors: the characteristics of magnetic nanoparticles (size, surface, magnetic properties), radionuclide's characteristics (energy, tissue range, half-life), stability of radiolabeled magnetic nanoparticles, external factors (external magnetic field), while the choice of the radionuclide depends on the nature of the specific medical procedure, location, size and nature of the treated tumor.

Methods of synthesis of magnetic nanoparticles coated with new biocompatible materials (citrates, PEG, HSA, phosphates) have been developed, labeling with appropriate radionuclides has been optimized, and their physicochemical and biological properties have been tested in the past two years.

Radiotracer method was used for the determination of in vitro (in human serum) and in vivo (on Wistar rats) stability of radiolabeled magnetic nanoparticles and pharmacokinetic parameters for their potential application in the treatment of malignant tumors.

#### Application of radiotracer methods in different studies

Researchers of the Laboratory for Radioisotope have cooperation with many institutes and faculties in the country and abroad. Radiotracer methods (Laboratory for radioisotopes is licensed for its use), as very specific and sensitive, have found significant application in the testing of new materials, as well as in the studies of the pharmacokinetics of new drugs. This method has been successfully applied for the testing of the biodistribution of hydroxyapatite nanoparticles labeled with  $^{125}\text{I}$  intended for the application in regenerative therapy. Radioimmunoassay is also proved as the most sensitive method used for determination of very low levels of hormones (thyroid, steroid etc.) in animals (cooperation on projects of the Faculty of Veterinary medicine).

#### PRODUCTION OF RADIOPHARMACEUTICALS FOR DIAGNOSIS AND THERAPY

During the long-term scientific research and in cooperation with nuclear medicine centers in the country and abroad, the Laboratory for Radioisotope has developed a wide range of radiopharmaceuticals that are used in diagnosis and therapy.

Today, the Laboratory for Radioisotopes is the unique center in the Balkan region, registered by the Ministry of Health of the Republic of Serbia, for the production of radiopharmaceuticals.

#### $^{99}\text{Mo}/^{99}\text{mTc}$ generator

Laboratory for Radioisotope has been producing a radionuclide Universal  $^{99}\text{Mo}/^{99}\text{mTc}$  generator for derivation of  $^{99}\text{mTc}$  in the form of sodium pertechnetate for 35 years.

Sodium pertechnetate is used for the imaging and functional studies of the thyroid, brain, salivary glands, gastrointestinal tract, while in the form of compounds labeled with  $^{99}\text{mTc}$  it is used for the imaging of the different organs and tissues.

### Proizvodnja radiofarmaceutika u Laboratoriji za radioizotope

*Radiopharmaceutical production in the Laboratory for radioisotopes*



#### Natrijum jodid- $^{131}\text{I}$ kapsule za terapiju

Osim radiofarmaceutika za dijagnostiku, u Laboratoriji za radioizotope se proizvode i terapijski radiofarmaceutici. Natrijum jodid- $^{131}\text{I}$  kapsule se primenjuju u terapiji hipertireoza i karcinoma štitaste žlezde u vodećim centrima za terapiju oboljenja štitaste žlezde u našoj zemlji: Institutu za onkologiju i radiologiju Srbije, Specijalnoj bolnici za bolesti štitaste žlezde i bolesti metabolizma "Zlatibor", Centru za nuklearnu medicinu KC Niš i dr.

#### Sodium iodide- $^{131}\text{I}$ capsules for therapy

Laboratory for radioisotopes also produces radiopharmaceuticals for the therapy. Sodium iodide  $^{131}\text{I}$  capsules applied for the treatment of hyperthyroidism and thyroid cancer are used in the leading centers for the treatment of thyroid disorders in our country: Institute of Oncology and Radiology of Serbia, Special Hospital for thyroid gland diseases and metabolic diseases "Zlatibor", Center for Nuclear Medicine KC Niš and others.

**Tokom protekle dve godine više hiljada pacijenata je primilo Vinčine radiofarmaceutike u različitim dijagnostičkim i terapijskim procedurama**

**Over the past two years, thousands of patients have received Vinca's radiopharmaceuticals in different diagnostic and therapeutic procedures**

#### KONTROLA RADIOFARMACEUTIKA

#### QUALITY CONTROL OF RADIOPHARMACEUTICALS

Laboratorija za radioizotope je akreditovana kod Akreditacionog tela Srbije (ATS) prema standardu SRPS ISO/IEC 17025:2006 (akreditacioni broj 01-064) za obavljanje poslova ispitivanja u sledećem obimu:

- radijaciona ispitivanja (hemiska, biološka i mikrobiološka) radiofarmaceutika za *in vivo* primenu obeženih beta i gama emiterima,
- radijaciona ispitivanja (hemiska) radiofarmaceutika za *in vitro* primenu na bazi radioimuno testa i imunoradiometrijskog testa,
- radijaciona ispitivanja zatvorenih radioaktivnih izvora i kontejnera za privremeno čuvanje i transport radioaktivnog materijala.

Laboratory for radioisotopes is accredited laboratory, by the Accreditation Body of Serbia (ATS) according to the standard SRPS ISO / IEC 17025:2006 (accreditation number 01-064), for carrying out testing tasks in the following scope:

- Radiation tests (chemical, biological and microbiological) of radiopharmaceuticals (labeled with beta and gamma emitters) for *in vivo* application,
- Radiation testing (chemical) of radiopharmaceuticals for *in vitro* application based on radioimmunoassay and immunodiadometric test,
- Radiation tests of sealed radioactive sources and containers for the temporary storage and transport of radioactive materials.

# LABORATORIJA ZA RADIOPHYSIOLOGIJU I MOLEKULARNU GENETIKU

## DEPARTMENT OF RADIOBIOLOGY AND MOLECULAR GENETICS

### AKTUELNA ISTRAŽIVANJA

Istraživanja u našoj Laboratoriji obuhvataju kardiovaskularne bolesti, dijabetes, kancer i multiplu sklerozu kao bolesti koje su najviše zastupljene u našoj populaciji i predstavljaju najčešće uzročnike morbiditeta i mortalitata. Eksperimenti se odvijaju na nivou DNK, iRNK, mikro RNK i proteina kod eksperimentalnih životinja (u odnosu na pol i estradiol) i kod odabranih grupa pacijenata (takođe u odnosu na pol). Eksperimentalne životinje (pacovi) su ispitivane na specifičnom režimu ishrane (hrana bogata fruktozom i hrana bogata mastima) koji simulira karakterističan fenotip koji je asociran sa kardiovaskularnim bolestima i hroničnom inflamacijom koja se pojavljuje i kod ljudi. Studije asocijacije genских varijanti (SNP) kod odabranih grupa pacijenata su obuhvatile osobe obojih pola koje boluju od nekih kardiovaskularnih bolesti (karotidna i koronarna ateroskleroza, ishemijska bolest srca i mozga) a naročito one koje sa njima imaju asociran dijabetes ili metabolički sindrom.

Ispituju se i molekularni markeri tumorgeneze kod hormonski zavisnih tumora. Poseban fokus naših istraživanja je na kongenitalne anomalije bubrega i uretera koje kod dece predstavljaju najčešći uzrok gubitka funkcije bubrega. Ispitana je i genetska osnova individualne variabilnosti u farmakokineticima primenjenih lekova kod dece sa transplantiranim bubregom. Osim metoda molekularne biologije i genetike razvijamo i bioinformatičke metode koje koristimo za analizu velikog broja podataka koje dobijamo sa genetskog ekspresionog čipa i za analizu ontologije humanih fenotipova. Ispituju se i nove metode detekcije kancera i novi materijali sa mogućom primenom u biomedicini.



Promocija i popularizacija nauke, namenjena učenicima osnovnih i srednjih škola realizuje se u okviru programa: "Vinčina naučionica", "Otvorena vrata Institut-a Vinča" i "Vinčina letnja scena". Program osmišljen od strane naše laboratorijske grupe učenike upoznaje sa osnovama molekularne genetike, kroz teorijski i eksperimentalni pristup.

Promotion and popularization of science, dedicated to students of elementary and secondary schools in programs: "Vinča's scientific workshop", "Doors open at Vinča Institute" and "Vinča's summer scene". The programme designed by our laboratory team aims to demonstrate the basic concepts of molecular genetics to students, in terms of

Istraživanjima su definisani značajni molekularni, genetički i epigenetički markeri nastanka i progresije kardiovaskularnih bolesti, dijabetesa, kancera, multiple skleroze, hroničnih nezaraznih bolesti, kroz više nacionalnih i međunarodnih projekata, uz primenu najsvremenijih metoda i opreme u molekularnoj biologiji, uz translacioni potencijal primene u kliničkoj praksi.

Our research defines significant molecular, genetic and epigenetic markers of the onset and progression of cardiovascular diseases, diabetes, cancer, multiple sclerosis, the most common chronic noncommunicable diseases, through national and international projects and by using high-end equipment in molecular biology, showing the great potential for translation into clinical practice.

### CURRENT RESEARCH

We are investigating cardiovascular disease, diabetes, cancer and multiple sclerosis, diseases that are common in our population and represent the main causes of morbidity and mortality. We are doing the analysis on DNA, mRNA, miRNA and protein level on mouse models (regarding gender and estradiol) as well as in human patients (also gender specific). Experimental animals (rats) were subjected to specific diet (high fructose and high fat diet), which simulate specific phenotype associated with cardiovascular diseases and chronic inflammation that appears in humans. Selected group of patients of both genders were included in the genetic association studies of cardiovascular diseases (carotid and coronary atherosclerosis, ischemic heart disease and stroke) especially those that had diabetes and metabolic syndrome as comorbidity.

Also, the molecular markers of tumorogenesis and endocrine related tumors are investigated in our laboratory. The congenital anomalies of kidney and urinary tract in pediatric patients that can lead to chronic kidney disease are in particular focus of our research. Genetic basis of individual variability in the pharmacokinetics of applied drugs in children with transplanted kidney was also examined. Beside methods of molecular biology and genetics, we are developing bioinformatical methodology that we apply in analysis of large data sets from microarray experiments, and for human phenotype ontology. We also investigate the novel methods of cancer detection and new materials with possible application in biomedicine.

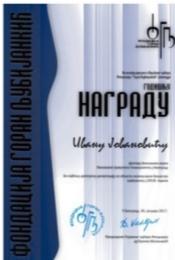
### GENETSKA OSNOVA HUMANIH INFLAMATORNIH I VASKULARNIH BOLESTI

Najveći doprinos istraživanja u prethodnom periodu je mogućnost definisanja specifičnih regulatornih mikroRNAs kroz integraciju novih prediktivnih algoritama i rezultata analize tkivo specifične ekspresije celokupnog genoma na mikročipu. Kapitalnu opremu za ovo Laboratorijsku je dobila u tekućem projektnom ciklusu. Ova studija je urađena kod dece sa kongenitalnim anomalijama bubrega i urinarnog traka i kao takva je prva u svetu dala informacije o mogućim terapijskim targetima za prevenciju oštećenja bubrega kod dece.

Oprema je jedinstvena u Srbiji. Na raspolaganju je svim istraživačkim grupama u Srbiji i ima veliki potencijal za primenu u dijagnostici i personalizovanoj medicini.

### GENETIC BASIS OF HUMAN INFLAMMATORY AND VASCULAR DISEASES

The greatest contribution of the research in the previous period is the possibility of defining specific regulatory microRNAs through integration of novel prediction algorithms and microarray tissue-specific whole genome expression. The Department obtained microarray equipment in the current project cycle. The study performed according to described design included children with congenital anomalies of the kidney and urinary tract, and as such was the first in the world to provide information on possible therapeutic targets for the prevention of kidney damage in children. The equipment is unique in Serbia. It is available to all research groups in Serbia and has great potential for application in diagnostics and personalized medicine.



Dr Ivan Jovanović je dobio prestižnu nagradu fondacije „Goran Ljubijankić“, za najbolji doktorat iz oblasti molekularne biologije u 2016. Dr Aleksandra Stanković dobila je nagradu Instituta Vinča za izuzetne rezultate u osnovnim istraživanjima u 2016.

Dr Ivan Jovanović got the prestigious reward from „Goran Ljubijankić“ Foundation, for the best doctoral thesis in the field of molecular biology, defended in 2016. Dr Aleksandra Stanković got the Institute Vinča reward for extraordinary results in basic research in 2016.



Hormonska regulacija ekspresije i aktivnosti azot oksid sintaze i natrijum-kalijumove pumpe u eksperimentalnim modelima insulinske rezistencije, dijabetesa i kardiovaskularnih poremećaja

Hormonal regulation of expression and activity of the nitric oxide synthase and sodium-potassium pump in experimental models of insulin resistance, diabetes and cardiovascular disorders

Rezultati koji se odnose na *in vivo* efekte estradiola na regulaciju bioloških markera pokazuju:

1. da u stanjima gojaznosti i IR, estradiol pozitivno reguliše metabolizam glukoze, lipida i produkciju nitrata/nitrite
2. da dijeta bogata mastima dovodi do:
  - povećanja ekspresije iNOS proteina mehanizmom koji uključuje Akt i NFkB-p50 proteine kod ženki pacova
  - promena u ekspresiji natrijum-kalijumove pumpe, mehanizmom koji uključuje RhoA/ROCK i IRS-1/PI3K signalne puteve kod ženki pacova
  - polno specifičnih promena u metabolizmu masti i glukoze
  - promena u ekspresiji iNOS i produkciji NO u jetri mužjaka i ženki pacova, što najverovatnije doprinosi polno specifičnom razvoju IR

Navedeno ukazuje na nove mogućnosti u terapijskoj primeni estradiola u lečenju kardiovaskularnih komplikacija tako i patoloških stanja jetre.

The results regarding *in vivo* effects of estradiol on the regulation of biomarkers show:

1. estradiol positively regulates the metabolism of glucose, lipids and the production of nitrate/nitrite in HF diet-induced obesity and IR
2. HF diet:
  - increases iNOS protein expression via the mechanism that includes Akt and NFkB-p50 signaling molecules in female rats
  - leads to differential sodium pump expression through RhoA/ROCK and IRS-1/PI3K signaling pathways in female rats
  - leads to altered hepatic glucose and lipid metabolism in a sex-specific manner
  - leads to altered hepatic iNOS expression and NO production in a sex-specific manner, leading to the different development of IR in male and female rats.

Published results represent the protective effects of estradiol, which points to novel possibilities in the treatment of cardiovascular complications and liver diseases.

## Integralna studija identifikacije regionalnih genetskih faktora rizika i faktora rizika životne sredine za masovne nezarazne bolesti humane populacije u Srbiji

## An integral study to identify the regional genetic and environmental risk factors for the common noncommunicable diseases in the human population of Serbia

Najvažniji rezultati dobijeni u 2016. i 2017. godini definišu značajne genetičke markere, koji se nalaze na hromozomskom lokusu 9p21, za nastanak ateroskleroze. Uočena je polno specifična asocijacija ispitanih genetičkih markera, kako pojedinačno tako i u haplotipu, sa nastankom bolesti u populaciji Srbije. Od važnosti je i rezultat o uticaju gena iz renin angiotenzin sistema i efekta regulatorne mikro RNK u nastanku i kliničkim komplikacijama u aterosklerozi.

Istraživanje izlaganja radonu u zatvorenim prostorijama, usredstveno na osnovne škole, u seoskim područjima, i u manjem opsegu na zatvorene prostorije u kojima ljudi borave i žive. Rezultati su prvi put primenila geostatističke metode na geografsku raspodelu koncentracije radona u izradi "mape škola sa radonskim rizikom". Urađena je i radonska mapa za Kosovo i Metohiju koja je integrisana u Evropsku mapu.

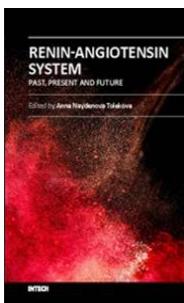
Publikovan je prikaz najznačajnijih nutritivnih faktora rizika za nastanak bolesti ishrane i dat je najnoviji pregled Evropskih preporuka za pravilnu ishranu i prevenciju masovnih nezaraznih bolesti. Prikupljene su tradicionalne recepture jela i analizirani je nutritivni sadržaj naročito sa aspekta dijetarnog unosa trans masnih kiselina, zaslicenih masnih kiselina i ukupnih masti, soli i drugih nutritivnih faktora rizika za nastanak KVB, kao i validaciju metode ispitivanja kvaliteta ishrane u Srbiji u odnosu na dijetarni unos vitamina D.

## Molekularne determinante za dizajn tumor markera

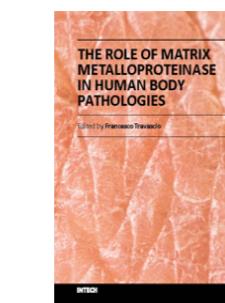
Predstavljena je nova metoda za detekciju melanoma i karcinoma dojke (Dramićanin, T., Dramićanin M., 2016, na slići)

Na molekularnom nivou, detekcijom ekspresije specifičnih gena i mikro RNK definisani su neki tumori (kancer dojke, VHL tumori i leukemije), koji mogu poslužiti za personalizovanu terapiju.

Napisan je program za procenu specifičnosti prajmera za MSP (eng. *Methylation specific PCR*) ili BSP (eng. *Bisulfite sequencing PCR*) (<http://www.vin.bg.ac.rs/180/tools/methspec.php>) u saradnji sa Centrom za Multidisciplinarnе studije, Institutu Vinča. Modifikovan je program BiNGO, za analizu Genske Ontologije (engl. *Gene Ontology*) u setu gena/proteina i proširena je funkcionalnost programa, tako da može da radi sa ontologijom humanih fenotipova (engl. *Human Phenotype Ontology*).

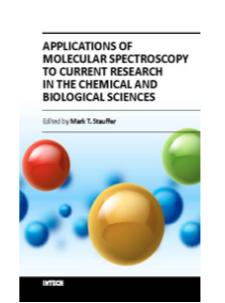


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December, 2017.



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October, 2016.

# LABORATORIJA ZA MOLEKULARNU BIOLOGIJU I ENDOKRINOLOGIJU

## DEPARTMENT OF MOLECULAR BIOLOGY AND ENDOCRINOLOGY

### O N A M A

Laboratoriјa za molekularну биологију и ендокринологију је основана 1949. год у Институту "Винча" у којој ради 50 запослених. Посвећена је основним, примененим и развојним истраживањима у молекуларној биомедицини, у областима: Нервна и ментална поремећаји, Молекуларна ендокринологија и метаболички поремећаји, Redoks медицина, Биологија и терапија канцера. Истраживања се реализују у оквиру 11 националних пројеката и пројекта Међународне сарадње са Италијом, Америком, Канадом, Великом Британијом, Хрватском, Немачком, Републиком Словачком (*Biophysical study of the effects induced by carbon ion beams and secondary particles produced by nuclear fragmentation, Grande Rilevanza Project (MAECl* – Министарство спољних послова и међународне сарадње Републике Италије), *Horizont 2020-ENSAR 2- European Nuclear Science and Applications Research 2, Networking Activities - NAs i Transnational Access Activities – TNAs*). Остварени научни резултати се могу окарактерисати као висококвалитетни и веома цитирани.

Остварена је сарадња са: Биолошким факултетом, Универзитет у Београду, Институтом за биолошка истраживања „Синиша Станковић“, Medicinskim факултетом, Универзитет у Београду, Факултетом за ветеринарску медицину, Универзитет у Београду, Клиничком центром Србије, хрватским институтом за истраживање мозга, Универзитет у Загребу, Заводом за молекуларну медицину, Институтом Рудер Босковић, Загреб, Фармацевутским факултетом, Универзитет у Београду, Стоматолошким факултетом, Универзитет у Београду, Факултетом спорта и физичког васпитања, Универзитет у Београду, Medicinskim факултетом, Универзитет у Нишу, Medicinskim факултетом, Kosovska Mitrovica, Универзитет у Приштини.

### ISTAKNUTO U 2016-2017

**Едукација:** Master, докторске дисертације и популатаризација науке, потписан Уговор са Medicinskim факултетом у Нишу- Институт представља научни и наставни базу.

### A B O U T U S

The Laboratory for Molecular Biology and Endocrinology was founded in 1949 at the Vinča Institute with 50 permanent employees. It is dedicated to basic, applied and developmental research in molecular biomedicine, in the fields of: Neuroscience and mental disorders, Molecular endocrinology and metabolic disorders, Redox medicine, Biology and cancer therapy. The research is carried out in the framework of 11 national projects and projects of International Cooperation with Italy, America, Canada, Great Britain, Croatia, Germany, the Republic of Slovakia (Biophysical study of the effects of carbon dioxins and secondary particles produced by nuclear fragmentation, Grande Rilevanza Project (MAECl – Ministry of Foreign Affairs and International Cooperation of the Republic of Italy), Horizont 2020-ENSAR – European Nuclear Science and Applications Research 2, Networking Activities - NAs and Transnational Access Activities – TNAs). The achieved scientific results can be characterized as high quality and highly cited.

Cooperation was established with: Faculty of Biology, University of Belgrade, Siniša Stanković Institute for Biological Research, Faculty of Medicine, University of Belgrade, Faculty of Veterinary Medicine, University of Belgrade, Clinic for Psychiatry, Clinical Center of Serbia, Croatian Institute for Brain Research, University of Zagreb, Department of Molecular Medicine, Ruđer Bošković Institute, Zagreb, Faculty of Pharmacy, University of Belgrade, Faculty of Dentistry, University of Belgrade, Faculty of Sport and Physical Education, University of Belgrade, Faculty of Medicine, University of Niš, Kosovska Mitrovica, University of Prishtina.

### 2016-2017 HIGHLIGHTS

**Education:** Master, PHD thesis and popularization of science; signed Contract with Faculty of Medicine in Niš- Institute represents scientific and teaching base.

Implementirana je Strategija Republike Srbije koja se odnosi na povezivanje naučnoistraživačkog rada, visokog obrazovanja i tržišta.

We consistently implemented the Strategy of the Republic of Serbia related to the linking of scientific research work, higher education, and the market.

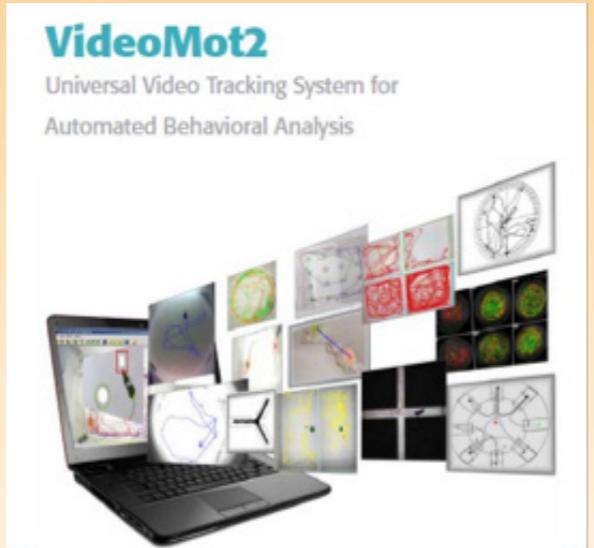


Laboratorija je bila suorganizator Međunarodne škole Geant4, 23. do 28.10.2016.

*The Department was a co-organiser of the International Geant4 School, 23 to 28 October 2016.*

#### AKREDITOVAN JE VIVARIJUM ZA UZGOJ ŽIVOTINJA

#### WE HAVE ACCREDITED OUR LABORATORY VIVARIUM



**Automatizovali smo sistem za praćenje ponašanja životinja**  
**We have automated our system for animal behaviour observation**



# LABORATORIJA ZA ZAŠTITU OD ZRAČENJA I ZAŠTITU ŽIVOTNE SREDINE

## DEPARTMENT OF RADIATION AND ENVIRONMENTAL PROTECTION

### O N A M A

Laboratorija za zaštitu od zračenja i zaštitu životne sredine je danas moderna organizacija koja ima preko 50 zaposlenih i pokriva sve aspekte zaštite od zračenja. Laboratorija se bavi osnovnim i primenjenim istraživanjima, ima razvijenu saradnju sa srodnim institucijama u zemlji i u svetu, realizuje kontrolu izvora zračenja i vodeća je institucija u ovoj oblasti u Srbiji.

Aktivnosti Laboratorijske usmerene su ka bezbednoj primeni izvora ionizujućih zračenja i transferu savremenih tehnoloških dostignuća na bazi ionizujućih zračenja u različite oblasti ljudskog delovanja. Ovi ciljevi mogu biti ispunjeni kroz istraživačke aktivnosti i primenu savremenih naučnih rezultata, praktična rešenja relevantna za korisnike izvora ionizujućih zračenja, obrazovne aktivnosti, negujući otvorenost, multidisciplinarnost i timski rad.

### DOZIMETRIJA I ZAŠTITA OD ZRAČENJA

Izloženost ionizujućim zračenjima je deo našeg prirodnog okruženja. Pored zračenja iz prirode, stanovništvo je izloženo ionizujućim zračenjima koja su posledica različitih aktivnosti sa prirodnim i veštackim izvorima zračenja. Centralna tema naših istraživanja jeste određivanje nivoa izlaganja na zadovoljavajućem nivou tačnosti.

Metrologija predstavlja osnovni činilac tehnološke infrastrukture. U oblasti primene ionizujućih zračenja, pouzdano rezultata merenja je od suštinskog značaja za zaštitu zdravila ljudi i životne sredine. Laboratorija vrši etaloniranje dozimetara za potrebe radioterapije, zaštite od zračenja i zaštite životne sredine i to u dozimetrijskim veličinama kerma u vazduhu, apsorbovana doza u vodi, lični dozni ekvivalent  $H_p(10)$  i  $H_p(0.07)$  i ambijentalni dozni ekvivalent  $H^*(10)$ . Laboratorija je član mreže sekundarnih standardnih laboratorijskih Međunarodne agencije za atomsku energiju i Svetske zdravstvene organizacije (IAEA/WHO) i nosilac nacionalnog etalona iz oblasti metrologije doze ionizujućeg zračenja.

### Različite aktivnosti laboratorijske zaštite od zračenja i zaštite životne

*Various activities of the Department of Radiological and Environmental Protection*

### ABOUT US

The Department is a modern organization with more than 50 employees covering all aspects of the radiation and environmental safety. We are involved in basic and applied scientific research in the area of radiation and environmental protection. We also provide independent services in protection of the public, workers and the environment from ionizing radiation and collaborate with similar organizations at national and international level.

Laboratory activities are focused on safe use of sources of ionizing radiation and transfer of contemporary technologies based on ionizing radiation in different areas of human life.

These goals are met through scientific research and accumulation of knowledge, practical applications, participation in educational and training activities, through openness, multidisciplinary and team work.

### DOSIMETRY AND RADIATION PROTECTION

The application of ionizing radiation is an important part of the modern medicine that enables transfer of high technologies to daily medical practice. The risk associated with exposure to ionizing radiation in medicine has to be controlled and well balanced with achieved benefits. The central topic of our research activities is assessment of radiation exposure in the accurate manner. Different experimental and computational methods for radiation dose and risk assessment are used to reduce the radiation burden for population, workers and patients, including dosimetry for early warning systems. Based on the fundamental radiation protection principles, services provided by our laboratory include testing of radiation sources in medicine and industry, workplace monitoring and individual monitoring, radiation protection consultancy, patient dosimetry and shielding design. The ionizing radiation calibration laboratory is a secondary standard dosimetry laboratory that maintains the standards of Gy and Sv, of which the one in Gy is national. The laboratory provides calibrations in terms of the Air Kerma, Absorbed Dose in water, Personal Dose Equivalent  $H_p(10)$  and  $H_p(0.07)$ , Ambient Dose Equivalent  $H^*(10)$  in the fields of radiotherapy, diagnostic radiology and radiation protection. The laboratory is member of the WHO/IAEA network of SSDL and closely cooperates with the Directorate of Measures and Precious Metals (DMDM). Since 2014, it is a Designated Institute (DI) for ionizing radiation and part of national metrology system.



## RADIOAKTIVNOST U ŽIVOTNOJ SREDINI

Značajan deo istraživačkih aktivnosti odnosi se na radioaktivnost u životnoj sredini i izučavanje ponašanja radionuklida u životnoj sredini, odnosno vazduhu, vodi, zemljištu i hrani. Pored toga, u laboratoriji se ispituje sadržaj prirodnih radionuklida u određenim industrijskim granama kao što je termoelektrika, proizvodnja veštačkih đubriva i proizvodnja građevinskih materijala. Rezultati ispitivanja sadržaja radionuklida se dalje koriste za izučavanje korelacije, za modelovanje procesa u životnoj sredini i procenu radijacionog rizika u vezi sa izlaganjem jonizujućim zračenjima. Laboratorija za zaštitu od zračenja i zaštitu životne sredine raspolaže sledećim metodama za određivanje sadržaja radionuklida: gamaspektrometrija, određivanje ukupne alfa i beta aktivnosti, određivanje sadržaja  $^{90}\text{Sr}$ , određivanje koncentracije radona i određivanje koncentracije tritijuma.



Laboratorija za gamaspektrometriju

## ZAŠTITA ŽIVOTNE SREDINE

### Materijali i metode za tretman/remedijaciju kontaminiranih voda i zemljišta

U okviru naučnih projekata istražuju se materijali i metode pogodne za tretman toksičnog i radioaktivnog otpada i tretman/remedijaciju zagađene vode i zemljišta. Istraživanje je fokusirano na nove sintetičke, mineralne i jeftine materijale pogodne za separaciju polutanata i drugih elemenata od interesa. Prateći globalne trendove u oblasti reciklaže otpada i zaštite prirodnih resursa, ispituje se mogućnost valorizacije otpadnih materijala i nusprodukata njihovom primenom kao sorbenta, agenasa za neutralizaciju i aditiva zemljištu. Istražuje se uticaj fizičkih, hemijskih i kombinovanih tretmana na performanse materijala, kao i efekti različitih faktora koji utiču na efikasnost sorpcije u vodenoj sredini, *in situ* immobilizacije metala u zemljištu i ekstrakcije zemljišta.

Za analizu i optimizaciju procesnih faktora primjenjuju se matematički modeli i statistički pristup. Za utvrđivanje mehanizma sorpcije i stabilnosti immobilisanih oblika zagađujućih materija koriste se hemijske analize, instrumentalne metode i različiti protokoli ličinga.

Teme istraživanja su multidisciplinarnе i imaju fundamentalni i praktični značaj.

### Aerozagadjenje i zaštita od toksičnih materija

Aktivnosti u laboratoriji uključuju istraživanja vezana za toksične hemijske materije, kao što su zagađivači prisutni u ambijentnom vazduhu u vidu gasova i respirabilnih čestica, istraživanja u vezi zaštite od pesticida, biocida i nanočestica u ambijentnoj i radnoj sredini, kao i istraživanja zaštite od hemijskih akcidenta. Hemijske zagađivače sagledavamo kroz "pristup celokupnog lanca" prateći ih od izvora, proučavamo njihovo prostiranje i transformisanje zaključno sa proučavanjem izloženosti ljudi u različitim mikrosredinama i posledičnim zdravstvenim efektima. Posebno interesovanje je posvećeno zagađenju vazduha i interakciji zagađivača u ambijentom vazduhu, monitoringu zagađenja i primeni optimalnih metoda i uređaja za analizu i praćenje različitih zagađivača (jeftini senzori za praćenje aerozagadjenja), modelovanju zagađenja vazduha (procena izvora primenom receptorskog modelovanja, mapiranje aerozagadjenja LUR modelovanjem,...), zagađenju vazduha u različitim mikrosredinama u zatvorenom prostoru, uzorkovanju aerosola i analizi sastava, određivanju brojčane koncentracije i raspodele veličina čestica u zatvorenoj sredini i spoljašnjem okruženju, modelovanju izloženosti ljudi na različite zagađivače vazduha, proceni rizika od izloženosti toksičnim hemikalijama i nanočesticama, proceni uticaja na zdravlje i ličnoj zaštiti od izloženosti toksičnim hemikalijama.

## ENVIRONMENTAL RADIOACTIVITY

Important part of our research activities is related to the environmental radioactivity as investigation of radionuclide behaviour in the environment (air, water, soil, food). In addition, laboratory provides services to investigate presence of natural radionuclides in certain industrial branches, thermal power plants, fertilizer production, building material production and many others. Results of the radionuclide activity assessment are further used to investigate correlations, for modelling of various processes and for the estimation of radiation risk associated with the exposure to ionizing radiation. Radiation and environmental protection department provides numerous services in the areas of radionuclide activity testing as gamma spectrometry, gross alpha and gross beta activity, assessment of  $^{90}\text{Sr}$  content, assessment of radon concentration and assessment of tritium concentration.

Gammaspectrometry laboratory

## ENVIRONMENTAL PROTECTION

### Materials and methods for the treatment/remediation of contaminated water and soil

Within the framework of scientific projects, the materials and the methods suitable for treatment of toxic and radioactive waste and treatment/remediation of contaminated water and soil are investigated. The research is focused on the novel synthetic, mineral and low-cost materials suitable for the separation of pollutants and other elements of interest. Following global trends in waste recycling and protection of natural resources, the beneficial use of waste materials and byproducts is explored through their application as sorbents, neutralizing agents and soil additives. The impact of physical, chemical and combined treatments on the performance of the materials is investigated, as well as the effects of different factors influencing the efficiency of sorption in aqueous media, *in situ* metal immobilization in the soil and soil extraction. For the analysis and optimization of the process factors, mathematical models and statistical approach are being implemented. Chemical analyses, instrumental methods and different leaching protocols are employed for the determination of the sorption mechanisms and the stability of the immobilized forms of pollutants. Research topics are multidisciplinary, with both fundamental and practical significance.

### Air pollution and protection from toxic chemicals

Activities in the laboratory include research of protection from toxic chemical species such as contaminants that are present in the ambient air in the form of gases and respirable particulate matter, research related to protection from pesticides, biocides and nanoparticles in the ambient and occupational environment and protection from chemical accidents. We study chemical hazards by utilizing the so-called "full chain approach" in which we observe hazards from source, dispersion, and transformation all the way to the exposure in different microenvironments and related health effects. Special interest is devoted to the following broad range of topics: air pollution and associated interactions in ambient air, air pollution monitoring-site selection and application of optimal methods and devices for the analysis of various air pollutants, novel sensors and devices for air pollutants monitoring (e.g. low-cost sensors), air pollution modelling (source apportionment using receptor models, LUR modelling,...), indoor air pollution in different microenvironments, respirable particulate matter sampling and composition analyses, particle count and size distribution in indoor and outdoor environment, modelling of human exposure to different air pollutants, risk assessment from exposure to toxic chemicals and nanoparticles, health impact assessment and personal protection from exposure to toxic chemical.

## SISTEM MENADŽMENTA KVALITETOM

Saradnici Laboratorije za zaštitu od zračenja i zaštitu životne sredine posvećeni su negovanju visokog kvaliteta usluga koje pruža Laboratorija u skladu sa uspostavljenim sistemom menadžmenta kvalitetom.

U okviru Laboratorije funkcioniše Laboratorija za radijaciona merenja koja je akreditovana prema standardu SRPS ISO/IEC 17025:2006 za etaloniranje i ispitivanje.

Detalji o obimu akreditacije Laboratorije za radijaciona merenja dostupni su ovde:

<https://www.vin.bg.ac.rs/100/index.php/akreditacija>

## QUALITY MANAGEMENT SYSTEM

Department of Radiation and Environmental Protection Department ensures that its calibration and testing services achieve a level of quality in execution and delivery that is commensurate with the requirements of its management system.

To achieve this, the management of the laboratory has leaded the effort to establish a management system in compliance with the SRPS ISO/IEC Standard 17025:2006. Details are available here:

<https://www.vin.bg.ac.rs/100/index.php/akreditacija>

## MAIN ACHIEVEMENTS

Main achievement of the Department can be summarized as:

- Bogata naučna produkcija, ostvarena kroz više od 100 radova objavljenih u međunarodnim časopisima tokom proteklih pet godina;
- Međunarodna saradnja: IAEA, EURAMET, EURADOS, Evropska komisija;
- Pružanje usluga visokog kvaliteta u skladu sa zahtevima standarda ISO 17025;
- Podrška korisnicima izvora zračenja za uspostavljanje pouzdanog i efikasnog sistema zaštite od zračenja;
- Podrška edukativnim programima iz zaštite od zračenja;
- Održavanje nacionalnog etalona u oblasti metologije jonizujućih zračenja;
- Doprinos monitoringu radioaktivnosti u Republici Srbiji, [www.srbatom.gov.rs](http://www.srbatom.gov.rs), [www.beograd.rs](http://www.beograd.rs), [www.tent.rs](http://www.tent.rs).
- Doprinos izgadnji sistema za delovanje u vanrednom događaju u Republici Srbiji;
- Dekontaminacija lokacija kontaminiranih istorijskim aktivnostima sa radioaktivnim materijama;
- Radiološki inženjerинг, održavanja izvora zračenja, dekomisija radijacionih objekata i radioaktivnih gromobrana;
- Dozimetrija za pacijente i pr cena doza za populaciju od medicinskih izvora zračenja.

## Laboratorija za zaštitu od zračenja i zaštitu životne sredine ovlašćena je od strane Agencije za zaštitu od zračenja i nuklearnu sigurnost Srbije za brojne aktivnosti u oblasti zaštite od zračenja

([www.srbatom.gov.rs](http://www.srbatom.gov.rs)) pre svega monitoringa i dekontaminacije.

**Department of Radiation and Environmental Protection is licensed by the Serbian Radiation and Nuclear Safety Agency for a number of activities in the area of radiation protection ([www.srbatom.gov.rs](http://www.srbatom.gov.rs)) primarily monitoring and decontamination.**

# LABORATORIJA ZA TERMOTEHNIKU I ENERGETIKU

## DEPARTMENT OF THERMAL ENGINEERING AND ENERGY

### POVEĆANJE ENERGETSKE EFIKASNOSTI I SMANJENJE AEROZAGAĐENJA IZ TERMOELEKTRANA NA LIGNIT

Na osnovu sprovedenih multidisciplinarnih usmerenih osnovnih i primenjenih istraživanja, tokom prethodnih godina osvojena su potrebna znanja o karakteristikama lignita i procesa njegove pripreme i sagorevanja u cilju povećanja energetske efikasnosti termoelektrana i smanjenja uticaja njihovog rada na zagađenje životne sredine, pre svega aerozagadenja. Takođe, obezbeđena je i savremena merna oprema iz sopstvenih sredstava kao i iz sredstava resornog ministarstva. Osvojena znanja na nivou najboljih tehnologija (BAT), tokom 2016/2017. godine primenjena su na termoblokovima u zemlji i inostranstvu:

- primena primarnih mera za smanjenje emisije azotnih oksida i ugljenmonoksida na nivoje ispod graničnih vrednosti ( $\leq 200 \text{ mg/Nm}^3$ ) propisane EU i domaćom legislativom na 300 MWe na blokovima A5 i A3 u TE „Nikola Tesla“-A, u Srbiji i u TE „Agios Dimitrios“-5, u Grčkoj
- smanjenje emisije praškastih materija na nivo ispod granične vrednosti ( $\leq 50 \text{ mg/Nm}^3$ ) propisane EU i domaćom legislativom na bloku 125 MW u TE „Morava“, Srbija

Takođe, tokom 2016/2017. godine, osvojena znanja su primenjena i za dijagnostiku procesa rada termoelektrana na lignit u cilju utvrđivanja stanja i uzroka mogućih poremećaja u radu u odnosu na režime rada sa najboljim mogućim stepenom korisnosti i najmanjom emisijom štetnih materija u vazduhu, kao i pri izvođenju garancijskih ispitivanja i to u:

- TE „Nikola Tesla“ na bloku A4 snage 300 MW (za pripremu kapitalnog remonta)
- TE „Kostolac“-A2 snage 200 MW (elektrofiltersko postrojenje)
- TE „Ugljevik“ snage 300 MW (elektrofiltersko postrojenje)
- kao i pri ispitivanjima kotla u gradskoj topnici u Kragujevcu.

### ENERGETSKA EFIKASNOST U ZGRADARSTVU

Implementacijom razvijene metodologije merenja energetskih karakteristika zgrada i uslova unutrašnjeg komfora u privatnim i javnim objektima, omogućili smo analizu kvaliteti postojećeg stanja ispitivanih objekata i mogućnost sprovođenja mera unapređenja: energetski karakteristika omotača objekta, parametara kvaliteta vazduha (smanjenja količine CO<sub>2</sub>) i parametara koji se odnose na ugodnost unutrašnjeg prostora (toplota ugodnost, buka i osvetljenje). Ovu metodologiju paralelno prati i numerička simulacija, koja omogućava predviđanje energetskih ušteda dobijenih primenom predloženih mera.

Primena metodologije je potvrđena dobijanjem licence za izdavanje sertifikata o energetskim svojstvima objekata visokogradnje od strane Ministarstva građevinarstva i urbanizma br. 35-00-001 13/2012-04.

### INCREASING ENERGY EFFICIENCY AND REDUCING AIR POLLUTION FROM LIGNITE THERMAL POWER PLANTS

In order to increase the energy efficiency of power plants and reduce the impact of their work on environmental pollution, especially air pollution, the necessary knowledge about the characteristics of lignite, its preparation process and its combustion were obtained, based on the above targeted multidisciplinary basic and applied research.

Also, modern measuring equipment was purchased from its own funds as well as from the funds of the line ministry.

During 2016/2017, Best-Tech Knowledge (BAT) were applied on thermocouples in the country and abroad:

- the application of primary measures for reducing the emissions of nitrogen oxides and carbon monoxide to levels below the limit values ( $\leq 200 \text{ mg/Nm}^3$ ) determined by the EU and national legislation to 300 MWe on blocks A5 and A3 in the TE “Nikola Tesla”-A, in Serbia and TE “Agios Dimitrios”-5, in Greece.
- the emission of dust substances reduction to a level below the limit value ( $\leq 50 \text{ mg/Nm}^3$ ) determined by the EU and domestic legislation on a 125 MW block in the TE Morava, Serbia.

During 2016/2017, the acquired knowledge was also applied to the diagnostics of the operation of thermal power plants on lignite process, in order to determine the state and cause of possible disruptions in operation in relation to the operating modes with the best possible degree of usefulness and the lowest emission of harmful substances in the air, as well as in carrying out warranty tests in:

- TE “Nikola Tesla” on A4 block of 300 MW (for preparation of capital overhaul)
- TE “Kostolac”-A2 power of 200 MW (electro-filter plant)
- TE “Ugljevik” power of 300 MW (electro-filter plant)
- as well as the boiler tests in Kragujevac heating plant

### ENERGY EFFICIENCY IN BUILDINGS

By implementing a developed methodology of measuring the energy characteristics of buildings and the conditions of internal comfort in private and public facilities, we have enabled analysis of the quality of the existing state of the tested facilities and the possibility of implementing measures of improvement: energy characteristics of the building envelope, parameters of air quality (reduction of CO<sub>2</sub>) and parameters related to the benefit of the interior space (thermal comfort, noise and lighting). This methodology is also accompanied by a numerical simulation, which allows predicting energy savings obtained by applying proposed measures.

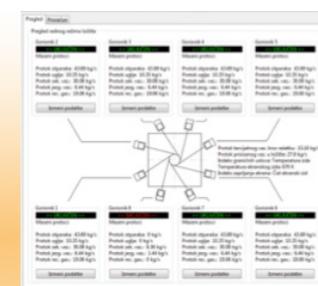
The application of the methodology is verified by obtaining a license for issuing certificates of energy performance of buildings by the Ministry of Construction and Urban Planning no. 35-00-001 13 / 2012-04.

### RAZVOJ I PRIMENA NUMERIČKIH MODELA PROCECA U SISTEMIMA ZA KONVERZIJU ENERGIJE

Istraživanja obuhvataju razvoj i primenu modela i softvera za predviđanje, analizu i optimizaciju strujanja, razmene toploće i materije u ložištima energetskih kotlova sa sagorevanjem ugljenog praha i drugim sistemima za konverziju energije, u cilju povećanja efikasnosti, redukcije emisije i transfera tehnologije ka korisnicima.

#### Istraživačke teme i aktivnosti

- Modeliranje dvofaznih turbulentnih tokova;
- Modeliranje sagorevanja i kosagorevanja uglja i biomase;
- Modeliranje toplotnog zračenja u ložištima za sprašeni ugalj;
- Razvoj i primena 3D CFD kodova i softvera;
- Simulacije i optimizacije procesa i termoenergetskih sistema;
- Tehnologije za sagorevanje uglja uz redukciju NO<sub>x</sub>, SO<sub>2</sub> i CO<sub>2</sub>



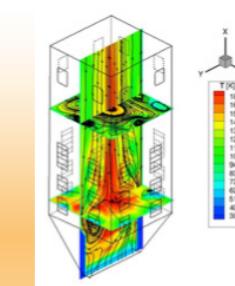
Glavni ekran korisničkog interfejsa razvijenog softvera  
*User-friendly interface of the in-house developed software*

### MODELING OF PROCESSES IN ENERGY CONVERSION SYSTEMS BY IN-HOUSE DEVELOPED SOFTWARE

Investigations focus on mathematical modeling and software development for simulation and analysis of flow, heat and mass transfer in pulverized-coal fired utility boiler furnaces and other energy conversion systems, in order to improve energy efficiency, reduce pollutants emission and technology transfer to end-users.

#### Research topics and activities

- Modeling of two-phase turbulent flows;
- Modeling of combustion and co-firing of coal and biomass;
- Modeling of thermal radiation in pulverized coal furnaces;
- Development and application of 3D CFD codes and software;
- Simulation and optimization of processes and energy systems;
- Clean coal technologies focused on NO<sub>x</sub> / SO<sub>2</sub> / CO<sub>2</sub> reduction



Strujnice i položaj plamena u ložištu na ugljeni prah  
*Streamlines and flame in the pulverized coal-fired furnace*

### SAGOREVANJE NEKONVENTIONALNIH GORIVA U FLUIDIZOVANOM SLOJU

#### Industrijski demonstracioni kotao sa FS snage 500 kW

Primarna aktivnost je bila vezana za završne radove na sklapanju, formirajući i puštanju u rad preseljenog industrijskog demonstracionog kotla snage oko 500 kW, namenjenog za ispitivanje insineracije karakterističnih otpadnih materija, odnosno sagorevanja nekonvencionalnih goriva u fluidizovanom sloju. Izrađena je prva verzija akumulatora toploće, kao i komandna soba sa merno-regulacionom opremom, čiji su najbitniji elementi kontinualni analizatori dimnog gasa (MRU SWG 200 i MRU SWG 300).

U okviru ispitivanja podobnosti sagorevanja nekonvencionalnih goriva na rekonstruisanoj i poboljšanoj instalaciji sa FS obaljeni su eksperimenti sa sagorevanjem ljuške lešnika i odseva rovnog uglja Kolubara.



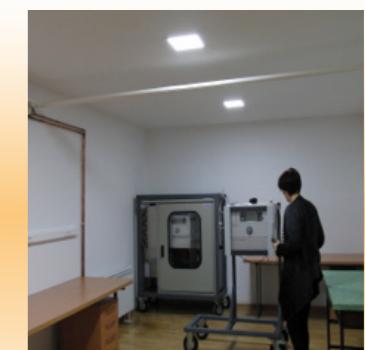
Industrijski demonstracioni kotao sa FS snage 500 kW  
*Industrial demonstration boiler with FS power of 500 kW*

### FLUIDIZED BED COMBUSTION OF UNCONVENTIONAL FUELS

#### Industrial demonstration boiler with FS power of 500 kW

The primary activity was related to the finalizing assembly, forming and commissioning of the relocated industrial boiler of about 500 kW, planned for incineration testing of characteristic waste materials, i.e. fluidized bed combustion of unconventional fuels. The first version of the heat accumulator was made, as well as the control room with measuring and control equipment, with the most important elements - continuous flue gas analyzers (MRU SWG 200 and MRU SWG 300).

In the framework of investigation of the suitability of unconventional fuels for combustion in FB, experiments with hazel shells and off-balance Kolubara coal were carried out in the reconstructed and improved installation.

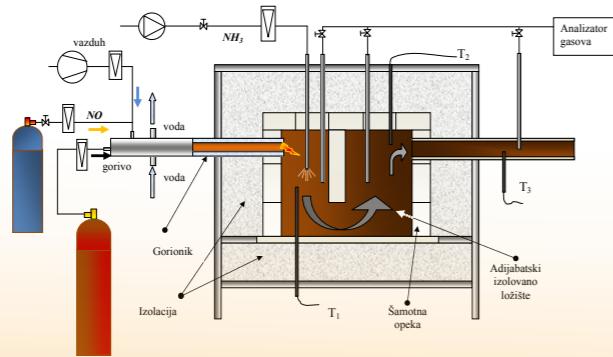


Komandna soba sa merno-regulacionom opremom  
*Control room with measuring and control equipment*

## OBNOVLJIVI IZVORI ENERGIJE

Za istraživanje mehanizma selektivne katalitičke redukcije, jedne od najzastupljenijih mera sekundarne denitrifikacije produkata sagorevanja, osmišljeno je i napravljeno adijabatsko ložište za simulaciju sagorevanja biomase, sa pratećom mernom i akvizicionom opremom.

Sprovedena su, takođe, i ispitivanja određivanja isparljivih i delimično isparljivih organskih jedinjenja, a posebno policikličnih aromatičnih ugljovodonika (PAHova) i trajnih organskih zagađivača POPs-a zbog njihovog potencijalnog toksičnog, kancerogenog ili mutagenog delovanja na prirodu i ljudsko zdravlje. Za ispitivanja je korišćena moderna merna oprema dobijena na projektima MPNTR i to: gasno-maseni hromatograf i tečni hromatograf visokih performansi HPLC. Cilj ispitivanja je razvoj i akreditacija metoda za određivanje pojedinih zagađivača posebno u slučaju korišćenja biomase.



**Šema adijabatskog ložišta za istraživanje procesa selektivne katalitičke redukcije**  
*Scheme of the adiabatic furnace for the investigation of the selective catalytic reduction process*

## METROLOŠKA LABORATORIJA ZA TERMOFIZIČKE VELIČINE, TEMPERATURU I VLAŽNOST

Tokom prethodne dve godine aktivnosti metrološke laboratorije za termofizičke veličine su se pretežno odvijale u dva pravca, podržana međunarodnim projektom 14RPT05 „EURA-THERMAL“ pod okriljem EURAMET. Jedan je održanje sledivosti i proširenje opsega merenja temperature, posebno u domenu radijacione termometrije, gde je opseg sledivog beskontaktnog merenja temperature proširen do 2000 °C a naša grupa po prvi put učestvovala u međulaboratorijskom poređenju etaloniranja pirometara u prošrenom opsegu.

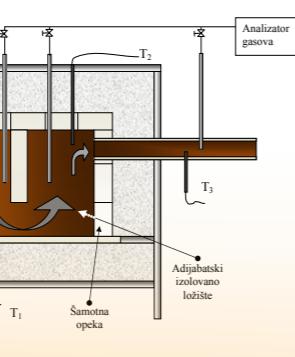
Drugi pravac razvoja se odnosi na status imenovane laboratorije za termofizičke osobine, što podrazumeva održavanje referentnih materijala i metrološko potvrđivanje učešćem u međulaboratorijskim šemama. U skladu s tim izvedena je serija merenja toplotne provodljivosti međunarodno sledivih referentnih materijala po metodi zaštićene tople ploče, i to: para uzoraka referentnog materijala IRMM-440 i jednog uzorka BCR-039, čime su verifikovane značajne izmene na jednoj aparaturi i pokazana validnost druge, napravljene većinom sopstvenim sredstvima.

Pored navedenog, grupa po prvi put učestvuje u organizaciji i izvođenju međulaboratorijskog merenja odabranih uzoraka polistirena, čime se u punoj meri uključuje u zajednicu laboratorija koje izvode merenja te vrste.

## RENEWABLE ENERGY SOURCES

In order to investigate the mechanism of selective catalytic reduction, one of the most frequent measures of secondary de-nitrification of combustion products, an adiabatic furnace for simulation of biomass combustion with accompanying measuring and acquisition equipment was designed.

Also, investigations were carried out to determine volatile and partially volatile organic compounds, in particular polycyclic aromatic hydrocarbons (PAHs) and persistent organic pollutants POPs, due to their potential toxic, carcinogenic or mutagenic effects on nature and human health. For testing, modern measuring equipment obtained from MPNTR projects was used: gas-mass chromatograph and high performance liquid chromatograph HPLC. The aim of the test is the development and accreditation of methods for the determination of certain pollutants, especially in the case of the biomass usage.



**Šema adijabatskog ložišta za istraživanje procesa selektivne katalitičke redukcije**  
*Scheme of the adiabatic furnace for the investigation of the selective catalytic reduction process*

## THERMOPHYSICAL PROPERTIES, TEMPERATURE AND HUMIDITY METROLOGY GROUP

Throughout previous two years, activities of VINS Laboratory for Thermophysical Properties have been undertaken mostly in two directions, supported by the EURAMET international project 14RPT05 "EURA-THERMAL". One direction is related to maintenance and expanding range of temperature measurement traceability, meaning that traceable contactless temperature measurement range was extended up to 2000°C, followed by our first international interlaboratory comparison on calibration of optical pyrometers in extended temperature range.

Another direction of development is related to our status of being the designated institute for thermophysical properties in Serbia. This includes reference materials maintaining, as well as metrological approval by participating in interlaboratory comparison schemes. According to this, a series of thermal conductivity measurements using the guarded hot plate method on international reference materials has been conducted, namely: a pair of IRMM-440 and a single BCR-039, that verified significant hardware changes on one apparatus model and proved validity of another model, mostly developed using our own resources.

In addition, the group for the first time participates in organizing and performing measurements in an inter-laboratory comparison on selected polystyrene specimens and, by that, fully includes itself in a society of laboratories capable to perform such measurements.

# LABORATORIJA ZA MATERIJALE DEPARTMENT OF MATERIALS

## O NAMA

Laboratorijska za materijale raspolaže stručnim kadrom (preko 35 doktora nauka iz oblasti nauke o materijalima), infrastrukturom i instrumentima koji se koriste u svrhu sinteze, modifikacije i karakterizacije različitih vrsta materijala: metalnih, keramičkih, karbonskih, kompozitnih itd. Veliki broj naučnih projekata, kako na nacionalnom tako i na međunarodnom nivou realizuju saradnici Laboratorijske. Saradnja sa privredom se oživljava i realizuje se kroz usluge određivanja sastava materijala, različitih mikrostrukturnih, mehaničkih i morfoloških osobina materijala, zatim, konsultinga, kao i izrada studija izvodljivosti sanacije zagađenih područja i otpadnih materija.

U okviru Laboratorijske za materijale funkcioniše „Centar za sintezu, procesiranje i karakterizaciju materijala za primenu u ekstremnim uslovima“, „CEXTREME LAB“, koji je akreditovan septembra 2015. godine od strane Odbora za akreditaciju naučnoistraživačkih ustanova i predstavlja jedini akreditovani Centar izvrsnosti u najvećem institutu u zemlji.

## CENTAR IZUZETNIH VREDNOSTI

Centar se bavi istraživanjima koji zahtevaju interdisciplinarni pristup; tj. osnovnim i primjenjenim istraživanjima na granici oblasti osnovnih nauka (hemija, fizika, biologija) i inžinjerstva. Za to su se istraživačke grupe različitih specijalizacija udružile, tj. napravile Laboratorijske kako bi radile na istom zadatu i efikasnije rešavale probleme, a sve u cilju povećanja neophodnih ljudskih resursa i istraživačke infrastrukture, odnosno kapaciteta za izvođenje konkretnih i aktuelnih istraživačkih aktivnosti, kao i povezivanje s drugim naučno-istraživačkim institucijama i centrima u zemlji i inostranstvu. Laboratorijske u okviru Centra su formirane ne samo za potrebe fundamentalnih istraživanja, nego i za specifična razvojna i primjenjena istraživanja.



## ABOUT US

Laboratory for material science has a professional staff (made up of more than 35 Ph.Ds in Material science), infrastructure and instruments used for the synthesis, modification and characterization of various types of materials: metals, ceramics, carbon materials, composite, etc. A large number of scientific projects, both at the national and international level, are carried out by the Laboratory's associates. Cooperation with the industry is reviving and was realized through the services of determination of composition, microstructural, mechanical and morphological properties of different kind of materials; consulting services; as well as feasibility studies for remediation of contaminated sites and waste materials. Further, Center for the synthesis, processing and characterization of materials for use in extreme conditions, "CEXTREME LAB", functions within the Laboratory of Materials Science and is accredited in September 2015th by the Committee for Accreditation of Scientific Research Institutions. It is the only officially accredited Center of excellence within the largest institute in the country.

## CENTER OF EXCELLENCE

The Center is engaged in research that requires an interdisciplinary approach; i.e. basic and applied research in the border area of basic sciences (chemistry, physics, biology) and engineering. Therefore, the research groups from different research fields have joined, i.e. formed Laboratories, in order to work on the same task and efficiently solved problems aiming to increase the necessary human resources and research infrastructure, and the capacity to perform specific and current research activities, as well as connect with other scientific-research institutions and centers in the country and abroad. Laboratories within the Center are formed not only for fundamental research, but also for specific development and applied research.

**Laboratorijska za kvalitativnu i kvantitativnu mikrostrukturnu analizu**  
**Laboratorijska za lasersko sinterovanje**  
**Laboratorijska za identifikaciju i strukturnu karakterizaciju materijala pomoću rendgenskog zračenja**  
**Laboratorijska za mehanička i spitivanja**  
**Laboratorijska za fizičko hemijsku karakterizaciju površina materijala za primenu u ekstremnim uslovima**  
**Laboratorijska za procesiranje i sintezu materijala za primenu u ekstremnim uslovima**  
**Laboratorijska za teorijsko istraživanje materijala**

**Laboratory for Qualitative and Quantitative Microstructural Analysis**  
**Laboratory for laser Sintering**  
**Laboratory for Identification and Structural Characterization of Materials Using X-Ray Diffraction Analysis**  
**Laboratory for the Physical and Chemical Surface Characterization of Materials for Application in Extreme Conditions**  
**Laboratory for Processing and Synthesis of Materials for Application in Extreme Conditions**  
**Laboratory for Theoretical Investigation of Materials (L-TIM)**

## ZNAČAJNA DOSTIGNUĆA 2016 - 2017

### Saradnja sa privredom

- Izrada studije o mogućnosti resanacije aleksandrovačkog jezera – teritorija grada Vranje
- Izrada tehničko-tehnološke studije izvodljivosti prerade 43 tone otpadnog opasnog mulja iz procesa galvanizacije- PPT-TMO AD Trstenik
- Saradnja sa NIS Novi Sad, Trajal Kruševac na mikrostrukturnoj karakterizaciji uzoraka, konsulting, itd.

### Međunarodni naučni projekti

- Erazmus+** projekt KA107 Međunarodna saradnja mobilnosti između University of Minho (Portugal) i Instituta za nuklearne nauke Vinča, Univerzitet u Beogradu
- COST** projekt - akcija MP1206, Electrospun nano-fibers for bio inspired composite materials and innovative industrial applications
- COST** projekt – akcija CA15202, Self-healing as preventive repair of concrete structures
- COST** projekt - akcija MP1208, Developing the physics and the scientific community for inertial confinement fusion at the time of NIF ignition
- Controlling defect chemistry of nanoporous oxide mayenite ( $12\text{CaO}\cdot7\text{Al}_2\text{O}_3$ ): A new class of electrides and ionic conductors, Institut za nuklearne nauke Vinča, Univerzitet u Beogradu; Institute of Nuclear Sciences, INR Dubna, Rusija
- Synthesis and modification of nanostructures generated by laser radiation, Institut za nuklearne nauke Vinča, Univerzitet u Beogradu; Institute of Physics, „Б.И.Степанов“, Nacional Academy, Belorusija
- Reaction mechanisms in the geopolymeric conversion of inorganic waste to useful products, Metallurgical Research Institute of Bucharest, Laboratory of Refractory and Advanced Ceramics and Academy of Science Romania; INN Vinča
- Bilateralni projekt** Slovačka-Srbija, Modification, characterization and properties of natural sorbents
- Gold/Ferrite nanocomposites: antimicrobial and magnetic properties for biomedical applications, Institut za nuklearne nauke Vinča, Univerzitet u Beogradu; Jožef Stefan Institute, Department of Nanostructured Materials, Ljubljana, Slovenija

### Nacionalni projekti

- Sinteza, procesiranje i karakterizacija nanostrukturalnih materijala za primenu u oblasti energije, mehaničkog inženjerstva, zaštite životne sredine i biomedicine
- Uticaj nano i mikrokonstituenata na sintezu i karakteristike novih kompozitnih materijala sa metalnom osnovom
- Mikromehanički kriterijumi oštećenja i loma
- Razvoj triboloških mikro/nano dvokomponentnih i hibridnih samopodmazi vajućih kompozita
- Razvoj tehnologije proizvodnje Pd katalizatora-hvatača za smanjenje gubitaka platine u visokotemperaturnim procesima katalize

**Centar za sintezu, procesiranje i karakterizaciju materijala za primenu u ekstremnim uslovima, CEXTREME LAB, <http://cextremelab.edu.rs/sr/>.**

**Center for the synthesis, processing, characterization for application in extreme conditions <http://cextremelab.edu.rs/en/>**

## 2016 - 2017 HIGHLIGHTS

### Cooperation with Industry

- Case study concerning restoration of Aleksandovac lake – municipality of Vranje city
- Technical-technological feasibility study for the treatment of 43 tons of waste hazardous sludge from process of galvanization- PPT-TMO AD Trstenik
- Cooperation with NIS Novi Sad, Trajal Kruševac regarding materials characterization, consulting, etc.

### International projects

- Erazmus+** project International Credit Mobility cooperation between University of Minho (Portugal) and University of Belgrade (Serbia), Institute for Nuclear Sciences Vinča
- COST Action MP1206**, Electrospun nano-fibers for bio inspired composite materials and innovative industrial applications
- COST Action CA15202**, Self-healing as preventive repair of concrete structures
- COST Action MP1208**, Developing the physics and the scientific community for inertial confinement fusion at the time of NIF ignition
- Controlling defect chemistry of nanoporous oxide mayenite ( $12\text{CaO}\cdot7\text{Al}_2\text{O}_3$ ): A new class of electrides and ionic conductors, Institute of Nuclear Sciences Vinča, University of Belgrade; Institute of Nuclear Sciences, JINR Dubna, Russia
- Synthesis and modification of nanostructures generated by laser radiation, Institute of Nuclear Sciences, Vinča, University of Belgrade; Institute of Physics, „Б.И.Степанов“, National Academy, Belarus
- Reaction mechanisms in the geopolymeric conversion of inorganic waste to useful products, Metallurgical Research Institute of Bucharest, Laboratory of Refractory and Advanced Ceramics and Academy of Science Romania; INS Vinča
- Bilateral project** Slovakia-Serbia, Modification, characterization and properties of natural sorbents
- Gold/Ferrite nanocomposites: antimicrobial and magnetic properties for biomedical applications, Institute of Nuclear Sciences Vinča, University of Belgrade; Jožef Stefan Institute, Department of Nanostructured Materials, Ljubljana, Slovenia

### National projects

- Synthesis, processing and characterization of nanostructural materials for application in energy research, mechanical engineering, environmental protection and biomedicine
- Effect of nano- and micro-structural constituents on synthesis and properties of modern metal matrix composite materials
- Micromechanical criteria of damage and fracture
- Development of tribological micro/nano two-component and hybrid self-lubricating composites
- Development of technology for production of the Pd catalyst catcher for reducing platinum losses in high-temperature catalytic processes



## DOGAĐAJI

### Četvrta konferencija Društva za keramičke materijale

Četvrta konferencija Društva za keramičke materijale održana je u Beogradu od 14. do 16. juna 2017. godine. Na konferenciji je predstavljen veliki broj tema interesantnih kako akademskoj zajednici tako i privrednicima. Konferenciju su zajedno organizovale najveće i najznačajnije institucije u Srbiji (Institut za nuklearne nauke „Vinča“ – CEXTREME LAB, Institut za multidisciplinarnе nauke, Institut za fiziku i Tehnološki fakultet Univerziteta u Novom Sadu). Konferencija je bila pravo mesto za naučnike, studente i privrednike, koji su želeli da imaju direktni pristup najvećoj i najznačajnijoj zajednici međunarodnih eksperata iz oblasti keramike u ovom delu Evrope.

### Kongres metalurgije i nauke o materijalima jugoistočne Evrope

Treći kongres metalurgije i nauke o materijalima jugoistočne Evrope (MME SEE 2017) održan je u Beogradu od 1. do 3. juna 2017. godine.

Kongres je organizovan uz podršku saveza metalurških inženjera jugoistočne Evrope i privrednih komora zemalja jugoistočne Evrope sa idejom da se pronađu inovativna rešenja za izazove i probleme savremene industrije.

## EVENTS

### 4th Conference of the Serbian Society for Ceramic Materials

4<sup>th</sup> Conference of the Serbian Society for Ceramic Materials was held in Belgrade from the 14th to the 16th of June 2017. Conference brought a wide range of related topics presenting the views from both academy and industry. This edition was organized jointly by the largest institutes in Serbia (Institute for Nuclear Sciences Vinča – CEXTREME LAB, Institute for Multidisciplinary Research, Institute for Physics, and Faculty for Technology-University of Novi Sad). Conference was the place for scientists, students and industrialists who were ready to have a direct access to one of the largest community of international experts in ceramic science and technology in this part of Europe.

### MME SEE 2017

The Third Metallurgical & Materials Engineering Congress of South East Europe (MME SEE 2017) was organized in Belgrade from the 1st to the 3rd June 2017.

The Congress is supported by SEE Associations of Metallurgical Engineers and Chambers of Commerce of SEE Countries with the idea to find innovative solutions for modern industrial challenges.

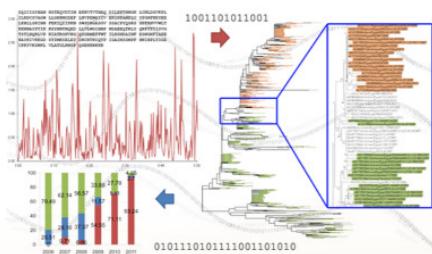
# CENTAR ZA MULTIDIŠCIPLINARNA ISTRAŽIVANJA I INŽENJERING

## CENTER FOR MULTIDISCIPLINARY RESEARCH AND ENGINEERING

### UVOD

U Centru za multidisciplinarna istraživanja i inženjering izvode se istraživanja iz oblasti bioinformatike i računarske hemije. Saradnici Centra razvijaju algoritme i analiziraju biološke i hemijske baze podataka. Metode razvijene za predviđanje funkcionalnog značaja mutacija i proteinskih interakcija se primenjuju na biološkim problemima vezanim za čoveka i humane patogene.

Veliku pažnju posvećujemo razvoju saradnje sa eksperimentalnim laboratorijama ukojima se validiraju rezultati naših *in silico* istraživanja.



### INTRODUCTION

Research in the field of bioinformatics and computer chemistry is carried out in the Center for Multidisciplinary Research and Engineering. The Center's collaborators develop algorithms and analyze biological and chemical databases. The methods for prediction of the functional importance of mutations and protein interactions, developed in the Center for Multidisciplinary Research, are applied to human biological problems related to human health and human pathogens. We give special attention to the development of collaborations with experimental laboratories where the results of our *in silico* research are validated.



U Centru za multidisciplinarna istraživanja i inženjering izvode se istraživanja iz oblasti bioinformatike i razvijaju algoritmi za analizu bioloških i hemijskih podataka

In the Center for Multidisciplinary Research and Engineering, research in the field of bioinformatics is carried out and algorithms are developed for the analysis of biological and chemical data.

### KOMPJUTERSKI PROGRAMI I BAZE PODATAKA

U periodu 2016/17. u Centru su razvijeni programi za predviđanje interakcija proteina u ćelijama čoveka koje su poremećene u različitim kompleksnim i infektivnim bolestima. Neki od njih su stavljeni na raspolaganje široj naučnoj javnosti i dostupni na našem sajtu <http://www.vin.bg.ac.rs/180>.

Ove informacije se koriste za predviđanje signalnih puteva u ljudskoj ćeliji i potencijalnih ciljnih molekula za terapiju.

Predviđanje karakteristika i patogenosti influenca virusa koji je konstantna i globalna pretnja za javno zdravlje je predmet studija u Centru dugi niz godina. Računarski alat ISTREE se primenjuje za praćenje evolucije virusa i za predviđanje patogenosti za čoveka. Saradnici Centra su učestvovali u pravljenju baze podataka DisProt (<http://www.disprot.org/>) koji je jedinstven svetski resurs informacija o neuredjenim proteinima.

### COMPUTER PROGRAMS AND DATABASES

In the period 2016/17 programs for prediction protein interactions in human cells that are disrupted in various complex and infectious diseases were developed in the Center. Some of the programs are available to the wider scientific public on the website <http://www.vin.bg.ac.rs/180>.

This information obtained is used to predict signal pathways in the human cell and potential target molecules for therapy.

Predicting the characteristics and pathogenicity of influenza viruses, a constant and global threat to public health is the topic of study at the Center for many years. The computer tool ISTREE is used to monitor the evolution of the influenza and for predicting human pathogenicity. The Center's collaborators took part in the creation of the DisProt database (<http://www.disprot.org/>), which is a unique worldwide resource of protein disorder.

Dr Branislavi Gemović saradnici Centra pripala nagrada "Fondacije Stanka Romac" za najbolji doktorat iz oblasti humane molekularne genetike i biomedicine za 2014-2016.

Dr. Branislava Gemović, received the "Stanka Romac Foundation" award for the best doctorate in the field of human molecular genetics and biomedicine for 2014-2016.

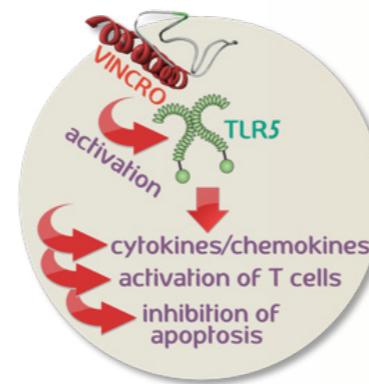
### PRIMENJENA ISTRAŽIVANJA U FARMACIJI

#### VINCRO: radioprotector

Istraživanja, zasnovana na originalnom pristupu koji je u Institutu Vinča razvijen pre 45 godina i koji danas primenjuju istraživači širom sveta, dovela su do otkrića molekula koji se može koristiti za zaštitu od ionizujućeg zračenja, VINCRO, koji je razvijen i patentiran u saradnji sa italijanskim Nacionalnim institutom za rak, CRO, pa otuda naziv koji je skraćenica imena naših instituta.

Ovaj molekul je peptid koji ukoliko se primeni kao terapija omogućava obolelima od raka da prime veću količinu terapije zračenjem jer štiti njihove zdrave ćelije od negativnih efekata.

Osim toga, veliki je interes za ove proizvode u svetu zbog rastuće tenzije oko mogućih nuklearnih napada, jer njihova primena omogućava da se ublaže efekti neželjene izloženosti zračenju.



### APPLIED RESEARCH IN PHARMACY

#### VINCRO: radio protector

The research is based on the original approach developed at the Institute of Nuclear Sciences VINCA 45 years ago and now applied by researchers around the world. This research has led to the discovery of a molecule named VINCRO that can be used in protection against ionizing radiation.

The molecule was developed and patented in cooperation with the Italian National Institute for cancer- CRO, and hence abbreviated name VINCRO. This molecule is a peptide that, if applied as a therapy, allows cancer patients to receive a higher doses of radiation by protecting their healthy cells from injury.

In addition, there is a huge global interest in radioprotectors due to the growing tension over possible nuclear attacks, as their application allows to mitigate the effects of unwanted exposure to radiation.

Kombinovane bioinformatička i eksperimentalna platforma Vinče i CRO-a može da pruži moćan odgovor na globalne radiološke pretnje, ali i da unapredi medicinske tretmane zasnovane na zračenju.

Combined bioinformatics and experimental platforms of Vinča and CRO serve as powerful response not only to global radiological threats, but also to limitations of radiological therapy.

## Nove primene lekova koji su na tržištu

Otkrivanje novih lekova i njihovo uvođenje na tržište je veoma skup i dugotrajan proces, a često se završava neuspehom jer farmaceutske kompanije moraju da odustanu od razvoja čak i u poodmakloj fazi, zbog toga što se otkriju neželjena dejstva ili se utvrdi da potencijalni lek nije dovoljno efikasan.

U Centru se izvode računarske pretrage koje mogu da ukazuju na nove primene lekova koji su već na tržištu.

Značajna dostignuća su otkriće da je:

- brufen, dobro poznati i svakom dostupan analgetik, osnova za razvoj terapije za Ebolu
- lek za snižavanje pritiska je smrtonosan za maligne ćelije i može da pojača dejstvo citostatika koji se uobičajeno koristi za lečenje raka

## OBRAZOVANJE

Centar je prepoznat po naučnim rezultatima, savremenim pravcima istraživanja i kvalitetnom radu sa budućim naučnicima, što ga čini privlačnim za mlade generacije biologa i hemičara. Ostvarena je saradnja sa fakultetima Univerziteta u Beogradu i Novom Sadu u izvođenju master i diplomskih radova. U toku 2017. su odbranjena 2 master rada, a u toku je izrada 2 master i jednog diplomskog rada rada. Pored formalnog obrazovanja, naši saradnici mentorisu istraživačke radove srednjoškolaca, koji na republičkim i međunarodnim takmičenjima privlače pažnju i osvajaju nagrade. Učenica Zemunske gimnazije Emilia Jovanović je sa radom o bioinformatičkoj analizi mutacija u leukemiji osvojila srebrnu medalju na Internacionalnoj konferenciji mladih naučnika (ICYS 2017) u Stuttgartu, Nemačka.

Pored toga, trudimo se da buduće naučnike kroz predavanja, međunarodnu saradnju i učešće na konferencijama i zimskim školama upoznamo sa svetskim i domaćim tokovima istraživanja. Master biolozi Univerziteta u Beogradu su 2016. uključeni u trening škole i konferencije o neuredenim proteinima. U aprilu 2017. godine, dr Perović je održao predavanje "Big data in biology" na beogradskoj internacionalnoj konferenciji molekularnih prirodnih nauka za studente (BIMLS – Belgrade International Molecular Life Science Conference for Students).

**Centar za multidisciplinarna istraživanja je bio organizator međunarodnog simpozijuma 2nd Symposium on non-globular proteins, 14-19.9.2016. koji je bio posvećen ulozi neglobularnih proteina u molekularnoj patofiziologiji.**

**The Center for Multidisciplinary Research was the organizer of the 2nd symposium on non-globular proteins, 14-19.9.2016. dedicated to the role of non-globular in molecular pathophysiology.**

## New uses for existing drugs

The discovery of new drugs and their introduction into the market is a very expensive and time-consuming process that often ends with failure. The reason for pharmaceutical companies to give up drug development, even in the advanced stages, are adverse effects a potential drug or insufficient efficacy.

The Center performs computer searches that can point to new applications of medicines that are already on the market. Significant achievements in this field are the discovery that:

- ibuprofen, well-known and widely available analgesic could be the basis for the development of Ebola therapy
- a medicine for lowering the blood pressure are deadly for malignant cells and can boost the effect of cytostatic that is commonly used for cancer treatment

## EDUCATION

The center is recognized by important scientific results, modern research directions and dedicated work in education of future scientists. That makes the Center attractive to young generations of biologists and chemists. Cooperation with the faculties of the University of Belgrade and Novi Sad was carried out in the performance of master and graduate thesis. In the course of 2017, 2 master works were defended, and 2 master and one graduate thesis are underway. In addition to formal education, our associates are also mentoring the research work of high school students, who attract attention and win prizes at Republic and international competitions. The student of the Zemun Gymnasium Emilia Jovanović won the silver medal at the International Conference of Young Scientists (ICYS 2017) in Stuttgart, Germany, on the bioinformatics analysis of mutations in leukemia.

Also, we strive through lectures, international cooperation and participation in conferences and winter schools to acquaint future scientists with worldwide and domestic research directions. Master biologists at the University of Belgrade in 2016 were involved in a training school and a conference on disordered proteins.

In April 2017, Dr. Perovic gave a lecture "Big data in biology" at the Belgrade International Molecular Life Science Conference for Students (BIMLS - Belgrade International Molecular Life Science Conference for Students).



# SPOLJNOTRGOVINSKI PROMET FOREIGN TRADE DEPARTMENT

## DELATNOST

Spoljnotrgovinski promet Instituta „Vinča“ je institutski centar, osnovan 1979. godine.

Registriran je za trgovinu na veliko farmaceutskim i hemijskim proizvodima, ostalim reprodukcionim materijalom i opremom.



## BUSINESS ACTIVITY

Vinča Institute Foreign Trade Department was established in 1979.

It is registered for wholesale activity in pharmaceutical and chemical products, other reproduction materials and equipment.



**Спљоњотрговински промет је водећи дистрибутер радиофармацеутика и извора јонизујућег зрачења зрачења у Републици Србији.**

**Our Foreign Trade Department is a leading distributor of radiopharmaceuticals and sources of ionizing radiation in the Republic of Serbia.**

## LICENCE I SERTIFIKATI

- Licencu Agencije za zaštitu od jonizujućih zračenja i nuklearnu sigurnost Srbije kojom se utvrđuje da ispunjava propisane uslove za obavljanje poslova uvoza, izvoza, prodaje i nabavke izvora ionizujućeg zračenja i njihovo bezbedno skladištenje i čuvanje u svojim prostorijama.
- Rešenje Ministarstva zdravljia o ispunjenosti uslova za promet lekova, pomoćnih lekovitih i medicinskih sredstava na veliko.
- Rešenje Ministarstva ekonomije i regionalnog razvoja o upisu u Registar lica koja mogu obavljati spoljnu kontrolisanom robom.
- Sertifikat SRPS ISO 9001:2008 kojim se potvrđuje da je sistem menadžmenta kvalitetom Spoljnotrgovinskog prometa Instituta "Vinča" koji se odnosi na trgovinu farmaceutskim i hemijskim proizvodima, radioaktivnim izotopima, pratećim reprodukcionim materijalom i opremom, carinsko posredovanje i špeditorske poslove proveren i usaglašen sa standardom kvaliteta SRPS ISO 9001:2008.

## LICENCES AND CERTIFICATES

- License of the Serbian Radiation and Nuclear Protection Agency by which it is determined that we meet the prescribed requirements for performing the activities of import, export, sale and procurement of sources of ionizing radiation and their safe storage and keeping in its premises.
- The Decision of the Ministry of Health on the fulfilment of the requirements for engaging in wholesale in medicinal products, accessory natural health products and medical aids.
- The Decision of the Ministry of Economy and Regional Development on the registration in the Registry of entities holding a permit to engage in foreign trade of controlled goods.
- The Certificate SRPS ISO 9001:2008 verifying that the quality management system of the Vinča Institute Foreign Trade Centre relating to the trade in pharmaceutical and chemical products, radioactive isotopes, accompanying reproduction materials and equipment, customs mediation services has been verified and in compliance with the quality standard SRPS ISO 9001:2008.



**Spoljnotrgovinski promet Institutu "Vinča" sarađuje sa svim vodećim zdravstvenim i naučnim ustanovama Republike Srbije kao i brojnim inostranim kompanijama.**

**Our Foreign Trade Department cooperates with all leading healthcare and scientific institutions of the Republic of Serbia and foreign companies around the world.**

# CENTAR ZA PROTIVEKSPLOZIVNU ZASTITU CENEx

**CENTRE FOR EXPLOSION PROTECTION CENEx**

## OSNOVNE DELATNOSTI

Centar CENEx se tokom poslednjih 20 godina prvenstveno bavi ispitivanjem i sertifikacijom sledećih proizvoda:

- opreme namenjene za upotrebu u eksplozivnim atmosferama (prema domaćem tehničkom propisu koji je u stvari transponovana evropska Direktiva ATEX)
- električne opreme niskog napona (prema domaćem tehničkom propisu koji je u stvari transponovana evropska Direktiva LVD)

Na osnovu dokazane kompetencije (putem akreditacija kao ispitna laboratorija), centar CENEx je deo nacionalnog Imenovanog tela koje je država ovlastila da u njeno ime obavlja poslove ocenjivanja usaglašenosti za navedene proizvode.

## BASIC ACTIVITIES

During the last 20 years Center CENEx has been dealing with testing and certification of next equipment:

- Equipment intended to use in potentially explosive atmospheres (according to Serbian rulebook which is actually transposition of European Directive ATEX)
- Low voltage electrical equipment (according to Serbian rulebook which is actually transposition of European Directive LVD)

Based on its competency (by accreditation as testing laboratory), center CENEx became a part of Serbian Notified body, which is appointed by relevant Serbian ministry to perform conformity assessment procedures for stated products.

## NAJZNAČAJNIJI REZULTATI U 2016/2017 GODINI

Tokom poslednje dve godine centar CENEx je značajno unapredio svoje ispitne kapacitete. Instalirana je nova merno ispitna oprema koja je po svojim performansama potpuno uporediva sa kapacitetima kod sličnih evropskih laboratorijskih.

Osim toga kadrovi centra CENEx su potpuno ovladali sa svim tehničkim specifičnostima koje proizilaze iz implementacije evropskog tehničkog zakonodavstva u pravni sistem Republike Srbije.

Nova merno ispitna oprema omogućava kredibilna ispitivanja koja se zahtevaju sa relevantnim evropskim standardima.

Lista opreme odgovarajućim standardima:

- Komora za eksplozivna ispitivanja opreme namenjene za upotrebu u eksplozivnim atmosferama (max. 50 bar, zapremina 1020 litara, EN 60079-1, Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d")
- "Siwek- 20 L komora" za određivanje parametara eksplozivnih prašina:
  - max. pritisak eksplozije Pmax. oblaka prašina max. stepen porasta pritiska eksplozije (dp/dt)max i indeksa Kst (Kmax) oblaka prašina,
  - donja granica eksplozivnosti DGE oblaka prašina, EN 14034:1, Determination of explosion characteristics of dust clouds - Part 1: Determination of the maximum explosion pressure pmax of dust clouds,
  - EN 14034:2, Determination of explosion characteristics of dust clouds - Part 2: Determination of the maximum rate of explosion pressure rise (dp/dt)max of dust clouds,
  - EN 14034:3, Determination of explosion characteristics of dust clouds - Part 3: Determination of the lower explosion limit LEL of dust clouds
- Uređaj za merenje nivoa elektromagnetskog zračenja aparata za domaćinstvo EN 62233 : Measurement methods for electromagnetic fields of household appliances and similar apparatus with regard to human exposure.

## MAIN RESULTS IN 2016/2017

During the last two years center CENEx has remarkable improved its testing capacities. It was installed new testing equipment, which is comparable with similar testing equipment in European testing laboratories. Beside that, technical persons from center CENEx adopted all necessary technical knowledge required by successful implementation of European directives in Serbian infrastructure of quality.

With new measuring equipment center CENEx can perform credible testing required by relevant European standards.

List of equipment and standards:

- Explosion resistant test chamber (resistant to 50 bar, volume 1020 liters), for indoor explosive testing of electrical equipment intended for use in explosive atmospheres, EN 60079-1, Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
- "Siwek vessel- 20 L apparatus" for determinig:
  - maximum explosion pressure Pmax of dust clouds,
  - maximum rate of explosion pressure rise (dp/dt)max and explosion index Kst (Kmax) of dust clouds,
  - lower explosion limit LEL of dust clouds EN 14034:1, Determination of explosion characteristics of dust clouds - Part 1: Determination of the maximum explosion pressure pmax of dust clouds,
  - EN 14034:2, Determination of explosion characteristics of dust clouds - Part 2: Determination of the maximum rate of explosion pressure rise (dp/dt)max of dust clouds,
  - EN 14034:3, Determination of explosion characteristics of dust clouds - Part 3: Determination of the lower explosion limit LEL of dust clouds
- Electromagnetic exposure level tester EN 62233 : Measurement methods for electromagnetic fields of household appliances and similar apparatus with regard to human exposure.


## MERNO ISPITNA OPREMA

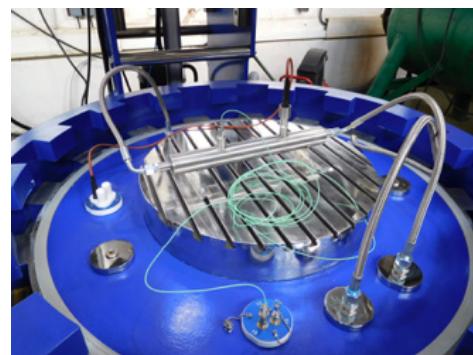
Komora za eksplozivna ispitivanja opreme namenjene za upotrebu u eksplozivnim atmosferama (max. 50 bar, zapremina 1020 litara).



Izgled komore spolja  
*Outside view of chamber*

## TESTING EQUIPMENT

Explosion resistant test chamber (to 50 bar, volume 1020 liters), for indoor explosive testing of electrical equipment intended for use in explosive atmospheres.



Izgled komore unutra  
*Inside view of chamber*

“Siwek - 20 L komora” za određivanje parametara eksplozivnih prašina



Izgled “Siwek” komore sa komandnim jedinicama  
*“Siwek” vessel with command units*

“Siwek vessel - 20 L apparatus”



“Siwek” komora  
*“Siwek” vessel*



Uredaj za merenje nivoa elektromagnetskih zračenja koje prokuju aparati za domaćinstvo



Home appliances electromagnetic exposure level tester



