Questionnaire
Summary of the main activities of the Institute of Physics of the Slovak Academy of Sciences

Period: January 1, 2012 - December 31, 2015

1. Basic information on the institute:

1.1. Legal name and address

Institute of Physics Slovak Academy of Sciences, Dúbravská cesta 9, 845 11 Bratislava, Slovakia, +421-2-59410501

1.2. URL of the institute web site

www.fu.sav.sk

1.3. Executive body of the institute and its composition

Directoriat	Name	Age	Years in the position
Director	RNDr. Stanislav Hlaváč, CSc.	68	5
Deputy director	Ing. Peter Švec, DrSc.	61	5
Scientific secretary	Mgr. Erik Bartoš, PhD.	40	2

1.4. Head of the Scientific Board – Mgr. Martin Veselský, PhD.

1.5. Basic information on the research personnel

1.5.1. Number of employees with university degrees (PhD students included) engaged in research projects, their full time equivalent work capacity (FTE) in 2012, 2013, 2014, 2015, and average number of employees in the assessment period

	2012		2013		2014		2015		total		
	number	FTE	number	FTE	number	FTE	number	FTE	number	averaged number per year	averaged FTE
Number of employees with university degrees	100.0	66.060	98.0	66.290	94.0	66.890	95.0	67.960	**387.0**	**96.8**	**66.800**
Number of PhD students	13.0	13.000	13.0	13.000	15.0	15.000	17.0	17.000	**58.0**	**14.5**	**14.500**
Total number	113.0	79.060	111.0	79.290	109.0	81.890	112.0	84.960	**445.0**	**111.3**	**81.300**

1.5.2. Institute units/departments and their FTE employees with university degrees engaged in research and development

Research staff	2012		2013		2014		2015		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
Institute in whole	100.0	66.060	98.0	66.290	94.0	66.890	95.0	67.960	**96.8**	**66.800**
Centrum pre výskum kvantovej informácie Research Center for Quantum Information	16.0	7.790	17.0	7.930	15.0	7.340	15.0	9.000	**15.8**	**8.015**
Oddelenie fyziky kovov Department of Metal Physics	19.0	13.530	21.0	13.320	17.0	13.910	16.0	13.020	**18.3**	**13.445**
Oddelenie jadrovej fyziky Department of Nuclear Physics	13.0	9.830	14.0	9.250	16.0	8.830	17.0	10.270	**15.0**	**9.545**
Oddelenie komplexných fyzikálnych systémov Department of Complex Physical Systems	18.0	12.190	17.0	12.610	15.0	12.520	15.0	12.500	**16.3**	**12.455**
Oddelenie multivrstiev a nanoštruktúr Department of Multilayers and Nanostructures	15.0	9.240	16.0	9.010	16.0	11.470	16.0	11.170	**15.8**	**10.223**
Oddelenie teoretickej fyziky Department of Theoretical Physics	6.0	4.250	6.0	4.250	6.0	4.580	5.0	4.410	**5.8**	**4.373**
Emeritni pracovnici, nezaradeni Emeritus staff	2.0	0.290	1.0	0.050	0.0	0.000	0.0	0.000	**0.8**	**0.085**

1.6. Basic information on the funding of the institute

Institutional salary budget and others salary budget

Salary budget	2012	2013	2014	2015	average
Institutional Salary budget *[thousands of EUR]*	898.920	906.868	867.450	955.523	**907.190**
Other Salary budget *[thousands of EUR]*	325.473	311.886	338.666	316.831	**323.214**

1.7. Mission Statement of the Institute as presented in the Foundation Charter

Mission of the Institute of Physics is experimental and theoretical research in solid state physics, in nuclear and subnuclear physics, in quantum information technologies, in electrical engineering, in automatization and control systems, in material engineering and in nanotechnologies.

The Institute of Physics provides advisory services for national and international customers, related to the Institute ‘s mission in which the Institute know-how and experimental equipment is used, including lease and retail of unique instruments, proprietary equipments and materials developed and produced by the Institute.

Institute provides doctoral studies for new scientific employees according to generally accepted regulations in scientific disciplines related to research activities of the Institute. Institute ensures the participation of its employees in the educational process at the Universities.

The Institute provides for publication of scientific and research findings through regular journals and nonperiodical publications. The Institute is publisher of the journal Acta Physica Slovaca.

1.8. Summary of R&D activity pursued by the institute during the assessment period in both national and international contexts, (recommended 5 pages, max. 10 pages)

Optimal discrimination of quantum measurement devices

Any successful verification of the correct functionality of quantum devices is rooted in our understanding of their experimental distinguishability. Indeed, discrimination tasks are naturally introducing operational concept of distance relevant for quantum communication and quantum computation applications. We have studied the discrimination of quantum measurements. In its simplest version of this task we know that a given measurement apparatus is performing one of two measurements and our goal is to design a test revealing its identity. In particular, we have shown that for perfect (one-shot) discrimination the ancilla-assisted discrimination algorithms are optimal. Proposed optimal procedures for unambiguous discrimination were experimentally implemented in collaboration with quantum-optics group in Olomouc. Performed experiments clearly exhibits that practical exploitation of quantum entanglement for discrimination purposes is feasible and entanglement provides a clear experimental evidence for the usefulness of quantum information processing.

Characterization of entanglement-annihilating processes

The phenomenon of quantum entanglement is one of the main demonstration of the difference between classical and quantum physics and most of the quantum information processing applications are based on this phenomenon. In our work we have focused on identification of those processes that completely destroys this purely quantum phenomenon, thus, making quantum information protocols and algorithms impossible. We managed to discover the structural properties standing behind entanglement-annihilation processes. We exploit our findings for analysis of the general features for continuous variable systems and reported on parameter intervals of noise acceptable for successful implementation of quantum-information experiments.

Suppression of interactions in multimode random lasers in the Anderson localized regime

Understanding random lasing is a formidable theoretical challenge. Unlike conventional lasers, random lasers have no resonator to trap light, they are highly multimode with potentially strong modal interactions, and they are based on disordered gain media, where photons undergo random multiple scattering. Interference effects notoriously modify the propagation of waves in such random media, but their fate in the presence of nonlinearity and interactions is poorly understood.
We developed a semi classical theory for multimode random lasing in the strongly scattering regime. They showed that Anderson localization, a wave interference effect, is not affected by the presence of nonlinearities. To the contrary, its presence suppresses interactions between simultaneously lasing modes. Consequently, each lasing mode in a strongly scattering random laser is given by a single long-lived, Anderson localized mode of the passive cavity, the frequency and wave profile of which do not vary with pumping, even in the multimode regime when modes spatially overlap.

Quantum Incompatibility

The existence of incompatible devices, for which there does not exist a single device that could replace them, is one of the basic features of quantum systems. Its consequences are practically all quantum no-go theorems (immeasurability of complementary physical variables, no-cloning theorem, no information without disturbance, etc.). In our works we have shown several interesting properties of quantum incompatibility and we have stated concrete conditions under which the incompatibility is destroyed. This sets the conditions under which several important quantum protocols cease to work. Furthermore we have discovered new dynamical properties of incompatibility similar to the structure of entanglement. It is quite possible that these results will lead to qualitatively new applications in the area of quantum information processing, as it was the case for the quantum entanglement. We have collaborated on this project with colleagues from institutions in Finland, Great Britain, Japan, Italy, and China, and in the past two years we have written 9 articles related to this topic. One of these works is an invited review on the topic of quantum incompatibility published in the Journal of Physics A.

Criticality without frustration for quantum spin-1 chains
Frustration-free (FF) spin chains have a property that their ground state minimizes all individual terms in the chain Hamiltonian. We ask how entangled the ground state of a FF quantum spin-s chain with nearest-neighbor interactions can be for small values of s. While FF spin-1/2 chains are known to have unentangled ground states, the case s=1 remains less explored. We propose the first example of a FF translation-invariant spin-1 chain that has a unique highly entangled ground state and exhibits some signatures of a critical behavior. The ground state can be viewed as the uniform superposition of balanced strings of left and right parentheses separated by empty spaces. Entanglement entropy of one half of the chain scales as log(n)/2 + O(1), where n is the number of spins. We prove that the energy gap above the ground state is polynomial in 1/n. The proof relies on a new result concerning statistics of Dyck paths which might be of independent interest.

Quantum Information Theory, Randomness and Statistics
Random numbers are a vital resource for many computational and cryptographic protocols. This fact is well known in classical information theory and there exist many results on the effect on imperfect – weak randomness on different algorithms, as well as protocols enhancing the quality of randomness. We contributed in this area by suggesting an improved version of a well-known Hadamard randomness extractor, which utilizes two independent sources of imperfect randomness to provide almost perfect random bits.
We showed that using quantum systems may provide security of cryptographic protocols that are provably insecure with only slightly weak randomness in classical theory. On contrary we showed that the well-known quantum key distribution protocol BB84 is totally insecure if even a negligible imperfectness in randomness used within the protocol occurs. Later we focused our research on device independent randomness production and showed the possibility of randomness extraction from a single min-entropy source, what is probably impossible classically.
The second part of our work was devoted to fundamental aspects of connection of thermodynamics and particle statistics. We reacted on a recent featured PRL letter about the influence of particle statistics on thermodynamics of a specific device – the Szilard engine. We corrected there several misunderstandings published in the original article and prepared also a complex manuscript on the same topic.

Strongly Interacting Matter under Extreme Conditions
The project was solved in cooperation with researchers from Matej Bel University in Banská Bystrica and Institute of Experimental Physics SAS in Košice.
Our part focused on the vacuum wave functional (VWF) of quantum chromodynamics (without dynamical quarks). Some time ago we proposed its form for the theory in (2+1) space-time dimensions and demonstrated, via numerical lattice simulations, that it represented good approximation to the true VWF. In this project we proposed a generalization of the approximate VWF for the realistic case of (3+1) dimensions. This state has the property of „dimensional reduction“ at large scales, meaning that the (squared) vacuum state, evaluated on long-wavelength, large scale fluctuations, has the form of the Boltzmann weight for Yang–Mills theory in three Euclidean dimensions. Our numerical results supported this conjectured behavior. We also investigated the form of the ground state evaluated on shorter wavelength configurations. With minor modification (which disappears in the continuum limit) the conjectured VWF on the lattice appears to be in harmony with vacuum amplitude data, obtained using the relative-weight method.

Confirmation of the existence of the f0(500) [σ-meson] from the analysis of pion scalar form factor
The explicit form of the pion scalar form factor, which is not an experimentally measurable quantity, was constructed by using its phase representation and a correct description of the S-wave isoscalar π-π phase shift data by the parametrization of its tangent in the absolute valued pion c.m. three momentum q. This parametrization has been found starting from fully general considerations of pion scalar form factor in the complex plane. Then a calculation of the corresponding integral in the framework of the theory of residua provides the pion scalar form factor in the form of a rational function with one zero and four poles in the q-variable. Investigations of the latter poles demonstrate that two of them, to be conjugate according to the imaginary axis in the q-plane, clearly correspond to lowest scalar meson f0(500) poles on the second Riemann sheet. This result

can be considered as model independent confirmation of the existence of f0(500), also known as σ-meson.

New form of an effective density dependence of nuclear interaction in the relativistic hadron field theory

Recent progress in astronomical observations, especially an accurate estimation of the mass of the pulsars J1614-2230 and J0348+0432, which yields values around $2\odot$, demands that any reliable nuclear equation of state (EoS) should be able to reproduce these results. Common feature of models that include hyperon degrees of freedom, kaon condensates or other forms of exotic hadronic matter is softening of the EoS along with the appearance of such particles, which complicates the model description of these high masses. The density dependent relativistic hadron field (DDRHF) theory is no exception. To help improve, or overcome this issue, we presented a new approach to the effective density dependence of DDRHF models, which include an introduction of 2-parametric class of density dependent functions. This class has several advantages in comparison to the typical choices of density dependence, namely smaller number of free parameters, enhanced stability of extrapolations to the higher densities and is universal with respect to various data. The 2-parametric class has been introduced and served as a base for a new parameterization of the more fundamental Dirac-Brueckner-Hartree-Fock calculations, which was subsequently used for obtaining results for symmetric and pure neutron matter. We have shown how important the mentioned assets of our new class are in comparison to other effective dependences on the density. We successfully applied the 2-parametric class to matter in beta-equilibrium, with focus on the lambda matter. Our results supported the usefulness of this class of density functions, and provided an improved equation of state. We believe that our approach is crucial for justifiable high-density extrapolations and thus important for any mean-field model of compact star physics.

Laser spectroscopy of astatine and the development of TATRA spectrometer

The ISOLDE is world-wide leader facility for production of radioactive-ion beams. It is using the infrastructure of pre-accelerators of the Large Hadron Collider for production of radioisotopes. Using the resonant laser ionization, the ionizing potential of astatine was determined experimentally. Astatine was the last remaining chemical element that naturally occurs on the Earth, which didn't have precisely measured the ionizing potential. Precise knowledge of chemical properties of astatine is crucial for proposed therapy of malicious tumors using alpha emitting isotopes. The 211At isotope is an excellent candidate for development of such radiopharmaceuticals.

An unique TATRA spectrometer enabling transport of highly radioactive ions from ISOLDE production target to high resolution electron and gamma ray detectors was developed. The TATRA system is using unique construction and novel materials in high-vacuum environment. Transport of ions is accomplished by their implantation into rapid quenched metallic glass, configured as an endless moving tape. It allows for simultaneous spectroscopy of conversion electrons and gamma rays following the beta decay of exotic radioactive isotopes. Spectrometer was successfully used in the IS521 experiment at CERN-ISOLDE, which was the first experiment at CERN, led by research group from Slovakia. The IS521 experiment established for the first time the excitation energy of the spherical configuration in mid-shell isotope. To achieve this, the breakthrough methodology for level scheme construction, based on modern Broad Energy Germanium detector, was developed.

Exact solution of the statistical mechanics of Coulomb systems

The basic work of the set is the monograph written in collaboration with Z. Bajnok. The monograph deals with principles of integrability (exact solvability) of various types of systems of interacting particles or spins. The universal approach is the Quantum Inverse Scattering Matrix method. The originality of the book consists in inclusion of the Quantum Field Theory, namely the complete solution of the quantum (1+1)-dimensional sine-Gordon theory and of the thermodynamics of the classical two-dimensional Coulomb gas. The publications concern in general the statistical description of classical Coulomb systems at low temperatures. A special task is the searching for the ground-state of the system of pointlike particles between charged plates which correspond to an idealization of the problem of the effective interaction of macro-ions in an electrolyte. In connection with this problem, a new effective method of lattice summations over Coulomb

interactions, which leads to quickly convergent series, was found. The phase structure, dependent on the distance between the plates, was derived for the general case with a dielectric inhomogeneity between the plates and the electrolyte medium.

Analytic calculation of the rectified current in rocking ratchets

The rocking ratchets (or Brownian pumps) represent one of the basic models of the Brownian motors, exploiting stochastic motion of the particles in bio- or nanochannels. Particles in the rocking ratchets are driven by a longitudinal oscillating force in an asymmetric channel. The asymmetry causes rectification of the oscillating net flow.

We showed that the one-dimensional description (obtained by our algorithm reducing the 2D or 3D evolution equations onto the longitudinal coordinate) enables us to calculate the rectified current analytically for any frequency of the sinusoidal oscillating force. We obtained a formula calculating its leading term, proportional to the amplitude of driving force squared. Our calculations verify and explain observations from the Brownian simulations: the rectified current reverts its direction in higher frequencies. It appears to be an effect of the asymmetrically growing phase delay between the oscillations of the concentration in different parts of a periodic channel and the driving force

Computer modelling on atomic scale: Nanomanipulation by noncontact atomic-force microscopy

Manipulation of atoms and molecules on surfaces, i.e. formation of nanostructures on surfaces at will, is one of the most interesting applications of non-contact/near-contact atomic force microscopy. In vertical manipulation the atoms are exchanged between the tip of the microscope and surface and a vertical manipulation is usually accompanied by an abrupt chemical or structural modification of the tip and imaging contrast. We have succeeded in realization of a vertical manipulation of copper atoms on oxidized Cu(110) surface in UHV at low temperatures, extraction of copper atoms from the surface and vice versa deposition of copper atoms onto the surface without apparent tip or imaging contrast change. The result was letter “X” written onto the Cu(110) surface readable by a subsequent scan. In order to understand these results, we have proposed an entirely new and general method, combining DFT calculations of energy barriers as a function of tip-sample distance with modified kinetic Monte Carlo, which makes possible to include the tip dynamics and calculate the statistics of manipulation processes. The model has revealed a novel 4-stage manipulation mechanism combining activated processes of jumps of manipulated copper atoms from and to the tip with their drag and diffusion along the cone shaped tip. The results represent atomic-scale realisation of dip-pen nanolithography.

Non-equilibrium phases in nanoparticle Langmuir films

It is well known that molecular Langmuir films exhibit a large number of structural phases depending on the surface pressure, subphase temperature and other external parameters. Less known are the structural phases formed during the assembling of colloidal nanoparticles confined at the air/liquid interface. In particular, non-equilibrium transient phases are unexplored that, however, may have a crucial effect on the self-assembled templates prepared by the Langmuir-Blodgett or Langmuir-Schaefer techniques. Therefore, a fast-tracking scheme of the grazing-incidence small-angle X-ray scattering technique (GISAXS) was developed to observe in-real time immediate response to the compression of a self-assembled plasmonic nanoparticle Langmuir film at the air/water interface and to identify for the first time all relevant intermediate phases including those far from the equilibrium. In particular, a new highly non-equilibrium transient phase preceding the monolayer collapse via the 2D-to-3D transition was discovered that is inaccessible by direct imaging vacuum techniques such as the scanning and transmission electron microscopies. To analyze the process, an original diffraction model of nanoparticle arrays based on a concept of hexagonal paracrystal was developed that allowed for the first time a complex structural analysis of the 3D self-assembled nanoparticle array. These results were selected for Research Highlights 2012 of the European Synchrotron Radiation Facility in Grenoble. These results are part of the complex studies of nanoparticle assemblies and their applications in chemical gas sensors based on FeO nanoparticles for explosive gases and in organic photovoltaic structures (below). With the multilayer nanoparticle assemblies prepared by Langmuir Schaefer method the NOx gas sensors achieved the ppb range.

New diagnostics and boosting performance of organic photovoltaics

Knowledge of the electronic band structure in terms of density of states (DOS) is a pre-requisite to tailor properties of semiconductor devices. In order to map DOS of organic semiconductors including defect states present in the forbidden band gap, we developed a new spectroscopic method, the energy-resolved electrochemical impedance spectroscopy (ER-EIS). It is the first method allowing to probe the whole band gap of organic semiconductors (from HOMO to LUMO) in a single measurement run and eliminating thus a need for combination of the spectroscopies of occupied (XPS) and unoccupied (EXAFS, XANES) states. The ER-EIS is particularly suitable for development of organic photovoltaics.
Several critical issues of organic solar cells (OSCs) were addressed. First, a hole-transport layer on the front transparent indium-tin-oxide (ITO) electrode of OSC was successfully replaced by ultraviolet/ozone treatment of ITO that is fully compatible with the roll-to-roll production. Second, application of gold plasmonic nanoparticles and nanorods on ITO enhanced the power conversion efficiency (PCE) by up to 20%. Third, superhydrophobic antireflective coatings with self-cleaning and anti-icing properties were developed to further enhance PCE and temporal stability of OSCs under real atmospheric conditions

Development and pilot application of new elements of X-ray optics for an extreme X-ray beam compression and expansion
The studies of nanostructures require also the development of innovative diagnostics. Original monolithic X-ray monochromators with a new added functionality of geometrical compression or expansion of the X-ray beam based on repeated asymmetric diffraction in a V-shaped channel were designed and prepared in collaboration with Integra, TDS, s.r.o. company, Piešťany. High compression (expansion) factors were achieved by original solutions of the refraction effect suppression that were verified experimentally in the compression and expansion modes. Advantages of the X-ray compressors comparing with traditional solutions were demonstrated on the small-angle X-ray scattering (SAXS) measurements where a resolution comparable to a synchrotron beamline was achieved. This opens new possibilities for laboratory SAXS and bio-SAXS experiments but also for X-ray diffraction (XRD). Pilot experiments showed applicability of X-ray expanders for 2D imaging in the absorption and phase contrast regimes with a resolution below 10 microns.

Nanocrystalline and quasicrystalline metallic systems with tailored structure and morphology
Joint effort of the entire project team using complementarity in expertise, equipment and combinations of theoretical approaches and ab-initio modeling with sample preparation technologies, broad range of experiments and newly developed physical processing methods has lead to progress in correlating the results obtained on different complex metallic systems and to their generalization. This contributed to development of two new classes of breakthrough new materials with high saturation magnetization and to enhancement in understanding of complex metallic structures and processes on atomic level. Significant progress (followed by international recognition together with proposal for cooperation from Tohoku University, Sendai, Japan) has been obtained in understanding and elucidation of selected catalytic processes related to the atomic structure of surfaces of complex intermetallic and in the interpretation of specific atomic ordering in these systems.

Application of Advanced Metallic Materials for Stiffness Enhancement of Lightweight Structural Components
Research activities have lead to new models, structures and composition of complex Al-based alloys with enhanced stiffness. It was shown that suitable combination of alloying and processing can yield elasticity moduli exceeding 100 GPa while keeping the material density comparable to those of classical Al-alloys. Optimized alloy based on AlCrFe used for preparation of combustion engine pistons allowed 30% reduction of piston mass. Special composites developed by compaction from Al powders reinforced with SiC or diverse nitrides have increased the stiffness of construction profiles prepared on industrial scales (ALULIGHT GmbH, SAPA Profily a.s.) by 50% as compared against equivalent conventional Al-profiles; in addition, significant enhancement of structure stability at elevated temperatures and of wear resistance has been achieved. Results lead to new lightweight materials with enhanced stiffness for applications in structural components, automotive sector, medicine, etc. reducing weight, energy and material consumption.

Extraordinary catalytic properties of surfaces of intermetallic compounds
In our works we studied the atomic structure, chemical reactivity and extraordinary catalytic properties of surfaces of intermetallic compounds. At the reaction of methanol with water on surfaces of three isostructural and isoelectronic compounds NiZn, PdZn, and PtZn we focused on understanding the mechanism of the catalytic selectivity of this important reaction. This methanol steam reforming (MSR) reaction can be used for hydrogen production for fuel cells. The MSR reaction can produce 6 hydrogen atoms per one molecule of CO2. Many tens of intermetallic compounds were tested as possible catalysts. In addition to sufficient catalytic activity and thermal stability the crucial problem is to find a catalyst with the correct selectivity. At the MSR reaction most of tested compounds produce besides CO2 also unacceptable CO. The Pd(111) surface is a very good dehydrogenation catalyst but it produces only CO instead of CO2. On the other side, the surface of PdZn has the desired CO2 selectivity. In our work we have explained the mechanism of the catalytic selectivity on the atomic scale. The possibilities how to improve the desired selectivity of the catalysts have been also presented.

Prediction of structure and stability of metallic alloys with complex structure
Al-rich aluminides often form in complex structures with genuine impact on physical properties: alloying metallic species can produce phases whose electronic properties range for example from metallic to semiconducting or even insulating.
Some phases only form in equilibrated state at low temperatures that may be inaccessible to experiments due to kinetic barriers. We have established effective approaches for modeling low-temperature equilibrium phases, and predicting their structure and stability. In AlCuSc system we described atomic motifs of a novel structure type, whose structure was later experimentally confirmed. In other cases, we screened electronic properties of hundreds of new alloys in a known structure, discovered low-temperature forms of a known complex high-temperature phase in Al-Ir system, or predicted new low-temperature phase in the technologically important AlFe alloy.

Thermal analysis of micro-, nano and non-crystalline materials
Fundamental, phenomenological kinetics of processes in micro-, nano- and non-crystalline solids was performed. The set of articles forms the review of known facts and methods of investigation of structural relaxation of glasses and of crystallization of both classic metallic glasses and precursors of nanocrystalline metallic alloys. All kinetic analyzes formulate, generalize and utilize two kinetic models of Dr. Illeková Ěmodel of structural relaxation with the distribution of non-linear relaxation times (DNLR) and model of crystallization based on th hypothesis of the existence of two principally different groups of non-crystalline metallic alloys, namely the classic metallic glasses and the precursors of nanocrystalline composites. The set of articles creates the model and methodical modern school of thermal analysis of non-crystalline solids.

Low-noise small fluxgate magnetic field sensor
The discouraging results and analysis of racetracks (avoid bending stress) noise testing and our experience with natural macroscopic heterogeneity of RQ rapid quenched ribbons led us to detour from the mainstream development, which necessitates to disable domain wall motion by strong transverse anisotropy and to have a material with truly homogeneous minimal magnetostriction not to deteriorate the transverse anisotropy by bending stress engaged by magnetoelastic coupling. Instead, we induced a modest transverse anisotropy and provided for simultaneous bending stress reduction by in-sheath axial-field annealing of toroidal core wound of selected low-magnetostrictive metallic-glass ribbon. Well reproducible noise figure of 7 pT/√Hz @ 1 Hz with the best cores showing 5 pT... has been attained with 12 mm diameter small cores. While the complete core development and testing comes from FU SAV Bratislava, sensor expertise, completion and noise testing is based at FEL CVUT Prague. The statement that the attained noise figure is the best one for this small fluxgate so far was objected neither by reviewers of our papers nor within discussions at conference presentations.

Device using wireless data transmission for monitoring of the temperature-moisture regime of cultural objects
Renovation and protection of cultural buildings falls into priority programs of the EU. We have designed and constructed a device with wireless communication for monitoring the temperature-moisture regime. It provides information about changes of the state of objects. Monitoring of the

state is based on long-term measuring of termophysical parameters. Constructed device implements operations related to measurement, data storage, and wireless communication. Design of the device was focused on need of low power consumption, long life and high reliability. The system includes also software that enables easy manipulation with the device using a computer via wireless connection. Using a suitable antenna on the computer side the connection can be realized up to several kilometers. After starting the computer utility software finds all devices in range. Then the user can select the device which with the wish to establish a connection. The device also supports solar charging of the batteries. It is useful especially when it is used in inaccessible areas. The device records the full range of thermophysical parameters of material and some meteorological conditions of environment. Included I2C interface allows extension for additional sensors. Temperature and moisture sensor is used to measure the atmosphere properties. For measuring of material properties we use thermophysical sensors. The device works with them via analog interface. The measured values are then converted to digital by 24-bit sigma - delta A/D converter. Sampling rate of the sensor signal can be set up to 50 Hz. Device and connectors fulfill IP68 standard. The device has two independent measuring channels, so placing sensors at the appropriate positions one can determine the energy balance of the building and moisture transport in the material. Power is provided by two AA batteries of RAM type. Devices are already used for monitoring temperature-moisture regime of the tower of St. Martin Cathedral in Bratislava.

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2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (ratios in percentage)

Basic research 91 %, applied research 9 %

International cooperation 90 %, regional importance 10%

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications listed for the assessment period should not exceed the average number of employees with university degrees engaged in research projects. The principal research outputs (max. 5, including Digital Object Identifier - DOI) should be underlined

1. Adamuscin, C; Dubnicka, S; Dubnickova, AZ
   New value of the proton charge root mean square radius
   PROGRESS IN PARTICLE AND NUCLEAR PHYSICS **3.662, Q1, Q2**
   Volume: 67
   Issue: 2
   Pages: 479-485
2. Rybar, T ; Filippov, SN ;Ziman, M; Buzek, V
   Simulation of indivisible qubit channels in collision models
   JOURNAL OF PHYSICS B-ATOMIC MOLECULAR AND OPTICAL PHYSICS **1.975, Q2,Q2,**
   Volume: 45
   Issue: 15
   Article Number: 154006
   Published: JUL 17 2012
3. Hillery, M; Zheng, HJ; Feldman, E ; Reitzner, D; Buzek, V
   Quantum walks as a probe of structural anomalies in graphs
   PHYSICAL REVIEW A **2.808, Q1, Q2**
   Volume: 85
   Issue: 6
   Article Number: 062325
   Published: JUN 27 2012
4. Dubecky, M ; Jurecka, P ; Derian, R ; Hobza, P ; Otyepka, M ; Mitas, L
   Quantum Monte Carlo Methods Describe Noncovalent Interactions with Subchemical Accuracy
   JOURNAL OF CHEMICAL THEORY AND COMPUTATION **5.498, Q1,Q1**
   Volume: 9
   Issue: 10
   Pages: 4287-4292
   Published: OCT 2013
5. Dubecky, M; Derian, R; Jurecka, P; Mitas, L; Hobza, P; Otyepka, M
   Quantum Monte Carlo for noncovalent interactions: an efficient protocol attaining benchmark accuracy
   PHYSICAL CHEMISTRY CHEMICAL PHYSICS **4.493,Q1,Q1**
   Volume: 16
   Issue: 38
   Pages: 20915-20923
   Published: 2014
6. Dubnicka, S; Dubnickova, AZ; Liptaj, A
   Pseudoscalar meson transition form factors

PROGRESS IN PARTICLE AND NUCLEAR PHYSICS **3.662, Q1, Q2**
Volume: 67
Issue: 2
Pages: 418-423

7. Dubnicka, S; Dubnickova, AZ; Liptaj, A
Pion scalar form factor and another confirmation of the existence of the f(0) (500) meson
PHYSICAL REVIEW D **4.643, Q1, Q1**
Volume: 90
Issue: 11
Article Number: 114003

8. Gendiar, A; Krcmar, R; Andergassen, S; Daniska, M; Nishino, T
Weak correlation effects in the Ising model on triangular-tiled hyperbolic lattices
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2.1.3 List of monographs/books published abroad

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2012

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KRAJČÍ, Marián - HAFNER, J. Catalytic Properties of Five-Fold Surfaces of Quasicrystal Approximants: Chapter 36. In Aperiodic Crystals. - Dordrecht: Springer, 2013, p. 269. ISBN 978-94-007-6430-9.

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2.1.4. List of monographs/books published in Slovakia

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad, incl. revenues

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia, incl. revenues

1. Title	Určovanie zmien optických hrúbok tenkých pasivovaných polovodičových vrstiev po pasivačných procedúrach / Determining changes in the optical thickness of thin semiconductor wafers passivated after passivation procedures
Number of patent	PV 5045-2014
Date of application	2014
Date of publication	--
Owner	Institute of Physics SAS
Authors	Brunner Róbert, Pinčík Emil

2. Title	Konštrukčný prvok na báze jedno- a viacvrstvového kovového skla a spôsob jeho výroby / The component based on single and multiple layers of the metallic glass and the method for producing
Number of patent	PP 44-2013
Date of application	10.05.2013
Date of publication	04.12.2014
Owner	Institute of Physics SAS, Slovak Centre of Scientific and Technical Information
Authors	Švec Peter, Janičkovič Dušan, Švec Peter ml., Hoško Jozef, Halász Michal

3. Title	Spôsob uskutočňovania lokálnej nábojovej tranzientnej analýzy / The way of making local charge transient analysis
Number of patent	PP 78-2012
Date of application	05.10.2012
Date of publication	03.06.2014
Owner	Slovak Centre of Scientific and Technical Information, Institute of Physics SAS
Authors	Lányi Štefan, Nádaždy Vojtech

4. Title	Viacvrstvové pásy na báze zliatin kovov a spôsob ich výroby / Multi-layer sheets of metal-based alloy and the method of their production
Number of patent	PP 50045-2014
Date of application	13.12.2011
Date of publication	03.09.2015
Owner	Institute of Physics SAS, Slovak Centre of Scientific and Technical Information
Authors	Švec Peter, Janičkovič Dušan, Švec Peter ml., Hoško Jozef, Halász Michal

5. Title	Spôsob prípravy polyakrylamidovej disperzie / A process for preparing a dispersion of polyacrylamide
Number of patent	PP 5034-2010

5. Title	Spôsob prípravy polyakrylamidovej disperzie / A process for preparing a dispersion of polyacrylamide
Date of application	03.10.2010
Date of publication	03.04.2012
Owner	Institute of Physics SAS, Institute of Polymers SAS
Authors	Capek Ignác, Majková Eva, Šiffalovič Peter

6. Title	Spôsob výroby nanočasticových monovrstiev a multivrstiev / A method for producing nanoparticle monolayers and multilayers
Number of patent	P 288234
Date of application	23.02.2010
Date of publication	04.12.2014
Owner	Institute of Physics SAS
Authors	Chitu Lívia, Majková Eva, Šiffalovič Peter, Jergel Matej, Luby Štefan

2.1.8. Table of research outputs (as in annual reports).

Scientific publications	2012			2013			2014			2015			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	1.0	0.013	0.001	1.0	0.013	0.001	1.0	0.012	0.001		0.000	0.000	**3.0**	**1.0**	**0.012**	**0.001**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000	**0.0**			
Chapters in scientific monographs published abroad *(ABC)*	5.0	0.063	0.006	7.0	0.088	0.008	2.0	0.024	0.002	1.0	0.012	0.001	**15.0**	**3.8**	**0.046**	**0.004**
Chapters in scientific monographs published in Slovakia *(ABD)*		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000	**0.0**			
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	101.0	1.278	0.112	76.0	0.959	0.084	105.0	1.282	0.121	69.0	0.812	0.072	**351.0**	**87.8**	**1.079**	**0.097**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS *(ADMA, ADMB, ADNA, ADNB)*	11.0	0.139	0.012	21.0	0.265	0.023	20.0	0.244	0.023	12.0	0.141	0.013	**64.0**	**16.0**	**0.197**	**0.018**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	1.0	0.013	0.001	3.0	0.038	0.003	1.0	0.012	0.001	2.0	0.024	0.002	**7.0**	**1.8**	**0.022**	**0.002**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	1.0	0.013	0.001	3.0	0.038	0.003		0.000	0.000		0.000	0.000	**4.0**	**2.0**	**0.025**	**0.002**
Scientific papers published in foreign peer-reviewed proceedings *(AEC, AECA)*		0.000	0.000	1.0	0.013	0.001		0.000	0.000	4.0	0.047	0.004	**5.0**	**2.5**	**0.031**	**0.003**
Scientific papers published in domestic peer-reviewed proceedings *(AED, AEDA)*		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000	**0.0**			
Published papers (full text) from foreign and international scientific conferences *(AFA, AFC, AFBA, AFDA)*	15.0	0.190	0.017	30.0	0.378	0.033	13.0	0.159	0.015	24.0	0.282	0.025	**82.0**	**20.5**	**0.252**	**0.023**
Published papers (full text) from domestic scientific conferences *(AFB, AFD, AFBB, AFDB)*	29.0	0.367	0.032	16.0	0.202	0.018	27.0	0.330	0.031	15.0	0.177	0.016	**87.0**	**21.8**	**0.268**	**0.024**

- **Supplementary information and/or comments on the scientific outputs of the institute.**

Without papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration)

Scientific publications	2012			2013			2014			2015			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	1,0	0,013	0,000	1,0	0,013	0,000	1,0	0,012	0,000		0,000	0,000	**3,0**	**1,0**	**0,012**	**0,000**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*		0,000	0,000		0,000	0,000		0,000	0,000		0,000	0,000	**0,0**			
Chapters in scientific monographs published abroad *(ABC)*	5,0	0,063	0,000	7,0	0,088	0,000	2,0	0,024	0,000	1,0	0,012	0,000	**15,0**	**3,8**	**0,046**	**0,000**
Chapters in scientific monographs published in Slovakia *(ABD)*		0,000	0,000		0,000	0,000		0,000	0,000		0,000	0,000	**0,0**			
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	87,0	1,100	0,000	66,0	0,832	0,000	96,0	1,172	0,000	54,0	0,636	0,000	**303,0**	**75,8**	**0,932**	**0,000**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS *(ADMA, ADMB, ADNA, ADNB)*	11,0	0,139	0,000	21,0	0,265	0,000	20,0	0,244	0,000	9,0	0,106	0,000	**61,0**	**15,3**	**0,188**	**0,000**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	1,0	0,013	0,000	3,0	0,038	0,000	1,0	0,012	0,000	2,0	0,024	0,000	**7,0**	**1,8**	**0,022**	**0,000**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	1,0	0,013	0,000	3,0	0,038	0,000		0,000	0,000		0,000	0,000	**4,0**	**2,0**	**0,025**	**0,000**
Scientific papers published in foreign peer-reviewed proceedings *(AEC, AECA)*		0,000	0,000	1,0	0,013	0,000		0,000	0,000	4,0	0,047	0,000	**5,0**	**2,5**	**0,031**	**0,000**
Scientific papers published in domestic peer-reviewed proceedings *(AED, AEDA)*		0,000	0,000		0,000	0,000		0,000	0,000		0,000	0,000	**0,0**			
Published papers (full text) from foreign and international scientific conferences *(AFA, AFC, AFBA, AFDA)*	15,0	0,190	0,000	30,0	0,378	0,000	13,0	0,159	0,000	24,0	0,282	0,000	**82,0**	**20,5**	**0,252**	**0,000**
Published papers (full text) from domestic scientific conferences *(AFB, AFD, AFBB, AFDB)*	29,0	0,367	0,000	16,0	0,202	0,000	27,0	0,330	0,000	15,0	0,177	0,000	**87,0**	**21,8**	**0,268**	**0,000**

2.2. Responses to the research outputs (citations, etc.)

2.2.1. Table with citations per annum.

Citations, reviews	2011		2012		2013		2014		total		
	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	averaged number per year	av. No. / FTE
Citations in Web of Science Core Collection (1.1, 2.1)	2223.0	28.118	1963.0	24.757	1537.0	18.769	1858.0	21.869	**7581.0**	**1895.3**	**23.312**
Citations in SCOPUS (1.2, 2.2) if not listed above	224.0	2.833	170.0	2.144	339.0	4.140	431.0	5.073	**1164.0**	**291.0**	**3.579**
Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)	1.0	0.013	1.0	0.013	1.0	0.012	1.0	0.012	**4.0**	**1.0**	**0.012**
Other citations (not listed above) (3, 4, 3.1, 4.1)	40.0	0.506	47.0	0.593	36.0	0.440	28.0	0.330	**151.0**	**37.8**	**0.464**
Reviews (5,6)		0.000		0.000		0.000		0.000	**0.0**		

- **Supplementary information and/or comments on the scientific outputs of the institute.**

Citation table whithout citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration)

Citations, reviews	2011		2012		2013		2014		total		
	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	averaged number per year	av. No. / FTE
Citations in Web of Science Core Collection (1.1, 2.1)	1259.0	15.925	1407.0	17.745	1212.0	14.800	1379.0	16.231	**5257.0**	**1314.3**	**16.165**
Citations in SCOPUS (1.2, 2.2) if not listed above	210.0	2.656	123.0	1.551	321.0	3.920	431.0	5.073	**1085.0**	**271.3**	**3.336**
Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)	1.0	0.013	1.0	0.013	1.0	0.012	1.0	0.012	**4.0**	**1.0**	**0.012**
Other citations (not listed above) (3, 4, 3.1, 4.1)	40.0	0.506	47.0	0.593	36.0	0.440	28.0	0.330	**151.0**	**37.8**	**0.464**

2.2.2. List of 10 most-cited publications, with number of citations in the assessment period (2011 – 2014).

1. Quantum secret sharing
   Hillery, M; Buzek, V; Berthiaume, A
   PHYSICAL REVIEW A Volume: 59 Issue: 3 Pages: 1829-1834 Published: MAR 1999
   Total 11-14**: 545**
2. Determination of effective permittivity and permeability of metamaterials from reflection and transmission coefficients
   Smith, DR; Schultz, S; Markos, P; et al. Markos
   PHYSICAL REVIEW B Volume: 65 Issue: 19 Article Number: 195104 Published: MAY 15 2002
   Total 11-14**: 518**
3. Semiconductor spintronics
   Fabian, Jaroslav; Matos-Abiague, Alex; Ertler, Christian; et al.
   ACTA PHYSICA SLOVACA Volume: 57 Issue: 4-5 Pages: 565-907 Published: AUG-OCT 2007
   Total 11-14: **236**
4. Quantum copying: Beyond the no-cloning theorem

Buzek, V; Hillery, M
PHYSICAL REVIEW A Volume: 54 Issue: 3 Pages: 1844-1852 Published: SEP 1996
Total 11-14: **131**

5. Resonant and antiresonant frequency dependence of the effective parameters of metamaterials
By: Koschny, T; Markos, P; Smith, DR; et al.
PHYSICAL REVIEW E Volume: 68 Issue: 6 Article Number: 065602 Part: 2 Published: DEC 2003
Total 11-14: **105**
6. Universal state inversion and concurrence in arbitrary dimensions
By: Rungta, P; Buzek, V; Caves, CM; et al.
PHYSICAL REVIEW A Volume: 64 Issue: 4 Article Number: 042315 Published: OCT 2001
Total 11-14: **92**
7. Entanglement by a beam splitter: Nonclassicality as a prerequisite for entanglement
By: Kim, MS; Son, W; Buzek, V; et al.
PHYSICAL REVIEW A Volume: 65 Issue: 3 Article Number: 032323 Part: A Published: MAR 2002
Total 11-14: **75**
8. Cluster emission, transfer and capture in nuclear reactions
Hodgson, PE; Betak, E,
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS Volume: 374 Issue: 1 Pages: 1-89
Total 11-14: **70**
9. Impact of inherent periodic structure on effective medium description of left-handed and related metamaterials
By: Koschny, T; Markos, P; Economou, EN; et al.
PHYSICAL REVIEW B Volume: 71 Issue: 24 Article Number: 245105 Published: JUN 2005
Total 11-14: **58**
10. Corrections to the Fick-Jacobs equation
Kalinay, P.; Percus, J. K.
PHYSICAL REVIEW E Volume: 74 Issue: 4 Article Number: 041203
Total 11-14: **58**

P. Markoš is at present professor at Faculty of Mathematics, Physics and Informatics of the Comenius University Bratislava, citations refer to papers published at Institute of Physics SAS

2.2.3. List of most-cited authors from the Institute (at most 10 % of the research employees with university degree engaged in research projects) and their number of citations in the assessment period (2011–2014).

1. Prof. RNDr. Vladimír Bužek, DrSc.	1549
2. RNDr. Peter Markoš, DrSc.	1016
3. Ing. Peter Švec, DrSc.	303
4. RNDr. Marián Krajčí, DrSc.	234
5. Ing. Matej Jergel, DrSc.	234
6. RNDr. Štefan Olejník, DrSc.	232
7. Ing. Mgr. Peter Staňo, PhD.	228

8.	RNDr. Eva Majková, DrSc.	214
9.	RNDr. Pavol Kalinay, CSc.	210
10.	RNDr. Marek Mihalkovič, CSc.	154

P. Markoš is at present professor at Faculty of Mathematics, Physics and Informatics of the Comenius University Bratislava, citations refer to papers published at Institute of Physics SAS

- **Supplementary information and/or comments on responses to the scientific output of the institute.**

  International Advisory Board of International Conference on Quasidrystalls selected our colleague Marek Mihalkovič to receive the 2016 Jean Marie Dubois Award. This Award recognizes important, sustained research on any aspect of quasicrystals within the 10-year period preceding the Award. The Award should be presented to Marek during ICQ 2016 in Nepal.

2.3. Research status of the institute in international and national contexts

- **International/European position of the institute**

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items.

1. Atomic-scale modeling of SPM imaging and Nano manipulation, organometallic nanoclusters with transition metal atoms and their relevance for spintronics
Collaboration with Kings College London, Osaka University, University Basel, Jagiellonian University Krakow, *Major project APVV-207-11*

2. Low-dimensional phenomena in equilibrium and non-equilibrium statistical mechanics
Collaboration with University Paris Orsay, *Major project VEGA 2/0049/12*

3. Functionalized Multiphase Materials (CEX FUN-MAT, 08/2011-07/2015)
Cooperation with Tohoku University Sendai, University Vienna, *Major projects CEX FUN-MAT, APVV 0495-11*

4. Nanocrystalline and quasicrystalline metallic systems with tailored structure and morphology
Cooperation with Technical University Athens, Carnegie Mellon University Pittsburgh, Tohoku University, Sendai, *Major projects NANOMORF, APVV-0492-11*

5. Application of Advanced Metallic Materials for Stiffness Enhancement of Lightweight Structural Components
Cooperation with Univ Oviedo, IUTA, Gijon, ALULIGHT GmbH, Ural Fed Univ, Ekaterinburg, Charles Univ Prague, Inst Ciencia Mat Madrid, Madrid, Natl Univ Sci & Technol MISIS, Moscow, Sharif Univ Technology, Tehran, Raja Ramanna Center for Advanced Technology, Indore, India, *Major projects ULTRALIGHT, APVV-0647-10*

6. Complexity and Quantum Information
Collaboration with University Ulm, TU Munich, University Turku, INFN Milan, Polytechnic University Milan, TU Darmstadt, ETH Zurich, *Major projects 7RP -600645, 7RP- 600788, APVV-0808-12*

7. Study of the Structure of Strong Interacting Elementary Particles

Cooperation with JINR, Dubna, CERN, Switzerland, Johannes Gutenberg University Mainz, Kazakh National University Almaty; Institute of Nuclear Physics, Cracow. *Major project APVV-0463-12, several grants of Slovak Plenipotentiary in JINR Dubna*

8. Study of nuclear shape coexistence in Au-Hg region
In cooperation with CERN-ISOLDE collaboration; JYFL –University of Jyvaskyla; iThemba LABS, Faure, South Africa; Australian National University Canberra; University of Liverpool; KU Leuven; IoP has two approved experiments at CERN-ISOLDE - IS521 and IS581. *Major projects APVV-0177-11, APVV-15-0225*

9. Nanoparticle assemblies: formation, diagnostics, applications
Cooperation with, National Synchrotron Radiation Research Center, Taiwan, ESRF Grenoble, HASYLAB Hamburg, Materials Institute of TUBITAK Marmara Research Center, Institute of Microelectronics and Microsystems, Lecce, Italy, Main projects APVV LPP -0175-09, SAS-NSC JRP, Taiwan 2011/05, SAS-TUBITAK No. ,2013-2016, SAS-CNR No.5, 2013–2015

10. Nanotechnology for active surfaces of the new generation X-ray optics for beam manipulation
Cooperation with HASYLAB Hamburg, Institute of Surface Modification Leipzig, IMRAM Tohoku University Sendai, *Major projects APVV-308-11, APVV-14-0745, M-ERA.NET XOPTICS, 2013–2016*

2.3.2. List of international conferences (co)organised by the institute.

2012
MECO37, Conference of the Middle European Cooperation in Statistical Physics, Tatranské Matliare, hotel Hutník, Vysoké Tatry, 19.03.-21.03.2012

SURFINT-SREN III 2012, Progress in Applied Surface, Interface, and Thin Film Science 2012, Florencia (Taliansko), 14.05. - 19.05.2012

CEQIP 2012 - Central European Quantum Information Processing, Smolenice, Slovakia, 07.06. - 10.06.2012

Relativistic Nuclear Physics: From Hundreds MeV to TeV, 2012, Stará Lesná, Slovakia, 18.06. - 22.06.2012

2013
CEQIP 2013 - Central European Quantum Information Processing, Valtice, Czech Republic, 05.06.-09.06.2013

The Proceedings of the 7th Joint International Hadron Structure´13 Conference, Tatranské Matliare, Slovakia, 30.06.-04.07.2013

Isospin, Structure, Reactions and Energy of Symmetry 2013, Častá - Papiernička, Slovakia, 22.09.-27.09.2013

NANOVED 2013 & NANO INFO DAY, Svit, Slovakia, 22.09.-25.09.2013

Spring workshop GEANT4, Somerset West, South Afrika, 29.10.-02.11.2013

2014
Meeting of Nuclear Reaction Data Centers 2014, Smolenice, Slovakia, 06.05.-09.05.2014

CEQIP 2014 – Central European Quantum Information Processing, Znojmo, Czech Republic, 05.06.-08.06.2014

Relativistic Nuclear Physics: From Hundreds MeV to TeV, 2014, Stará Lesná, Slovakia, 15.06.-20.06.2014

QUTE-Europe Summer School, Smolenice, Slovakia, 18.08.-28.08.2014

Thermophysics 2014, Podkylava 188, Slovak Republic, 08.10.-10.10.2014

HADES Collaboration Meeting XXVIII, Minisymposium "Strangeness and dilepton production in pion induced reactions", Bratislava, Slovakia, 27.10.-31.10.2014

2015
ISTROS 2015 – Isospin, STructure, Reactions and energy Of Symmetry, Častá-Papiernička, Slovakia, 01.05.-06.05.2015

C-MAC Euroschool 2015 - Material synthesis and characterization applied to complex metallic alloys, Aula SAV, Slovakia, 01.06.-05.06.2015

CEQIP 2015 – Central European Quantum Information Processing, Telč, Czech Republic, 18.06.-21.06.2015

Applied physics of condensed matter 2015, Hotel Patria, Štrbské Pleso, Slovakia, 24.06.-26.06.2015

Hadron Structure '15, Horný Smokovec, Slovakia, 29.06.-03.07.2015

4th Progress in Applied Surface, Interface and Thin Film Science - Solar Renewable Energy News SURFINT-SREN IV, Florencia, Italy, 23.11.-26.11.2015

2.3.3. List of edited proceedings from international scientific conferences.

2012
Progress in Applied Surface, Interface and Thin Film Science 2012 (SURFINT-SREN III), May 14-18, 2012, Florence, Italy . Extended Abstract Book. Editor R. Brunner. Bratislava: Comenius University, 2012. 197 s. ISBN 978-80-223-3212-5. Typ: FAI 200834

2013
Proceedings of 8th Solid State Surfaces and Interfaces (SSSI 2013), November 25-28, 2013, Smolenice Castle, Slovak Republic : Extended Abstract Book . Editor R. Brunner. Bratislava: Comenius University, 2013. 190 s. ISBN 978-80-223-3501-0. Typ: FAI 204247

HS´13. The Proceedings of the 7th Joint International Hadron Structure´13 Conference, June 30-July 4, 2013, Tatranská Štrba, High Tatra Mountains, Slovak Republic. In Nuclear Physics B (Proc.Suppl.), vol. 245, 2013 = Hadron Structure´13. Eds. S. Dubnička, A.Z: Dubničková, E. Bartoš . Amsterdam : Elsevier, 2013. 302 s. ISSN 0920-5632. Typ: FAI 205546

NANOVED 2013 & NANO INFO DAY : 6th International Conference on Nanosciences, Nanotechnologies, Nanomaterials and NANO INFO DAY of the Nanoforce Project , September 22-25, 2013, Svit, Slovakia : Program and Abstracts. Eds. P. Švec, I. Vávra, S. Surová. Brno : TRIBUN EU, 2013 . ISBN 978-80-263-0511-8. Typ: FAI 200834

2015
C-MAC Euroschool 2015. Materials Synthesis and Characterization Applied to Complex Metallic Alloys, June 1-5, 2015, Bratislava, Slovakia . (Program and Abstracts) Eds. M. de Boissieu, M. Mihalkovič, P. Švec . Bratislava : VEDA, 2015. ISBN 978-80-224-1441-8. Typ: FAI 223603

Proceedings of the 9th Joint International Hadron Structure ´15 Conference, Horný Smokovec, Slovak Republik, June29-July 3, 2015 . Eds. S. Dubnička, A.Z. Dubničková, E. Bartoš . Singapore : World Scientific Publishing Co., 2015. ISSN 2010-1945. Typ: FAI 228108

Progress in Applied Surface, Interface and Thin Film Science 2015 (SURFINT-SREN IV), November 23-26, 2015, Florence, Italy : Extended abstract book. Editor R. Brunner . Bratislava : Comenius University, 2015. 164 s. ISBN 978-80-223-3975-9. Typ: FAI 228529

2.3.4. List of journals edited/published by the institute:

2.3.4.1. WOS (IF of journals in each year of the assessment period)

- ACTA PHYSICA SLOVACA: Journal of Experimental and Theoretical Physics, ISSN 0323-0465, bimonthly periodicity

2012: 1.333, 2013: 2.000, 2014: 1.000, 2015: 0.500

2.3.4.2. SCOPUS

- ACTA PHYSICA SLOVACA: Journal of Experimental and Theoretical Physics, ISSN 0323-0465, bimonthly periodicity

2.3.4.3. other databases

- ACTA PHYSICA SLOVACA: Journal of Experimental and Theoretical Physics, ISSN 0323-0465, bimonthly periodicity

2.3.4.4. not included in databases

- **National position of the institute**

2.3.5. List of selected projects of national importance

2.3.6. Projects of the Slovak Research and Development Agency (APVV)

Slovak Research and Development Agency is a single national research supporting agency in Slovakia. The activity and support provided by APVV was in general perceived by research community in the recent past as not very satisfactory. Situation seems to improve at present. Detailed list of research projects supported by APVV is given in section 2.4.4.

2.3.7. Projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA)

Selected projects of VEGA Grant Agency

Coordinator	Project No.	Duration		Project title	Contribution			
		from	to		2012	2013	2014	2015
Dubnička	2/0009/10	02/2010	12/2013	Muon spectroscopy and validation of the Standard Model by more accurate evaluation of Alfa (M_Z) and muon g-2 anomalies Mezónová spektroskopia a overenie Štandardného Modelu presnejším vyhodnotením Alfa(M_Z) a miónovej g-2 anomálie	8 606,00 €	8 685,00 €		
Běták	2/0029/10	01/2010	12/2013	Nuclear reactions from MeV to the stars Jadrové reakcie od MeV k hviezdam	5 737,00 €	4 632,00 €		
Jergel	2/0041/11	01/2011	12/2014	Advanced photovoltaic structures with plasmon excitations effect on metallic nanoparticles Pokročilé fotovoltické štruktúry s efektom plazmónovej excitácie na kovových nanočasticiach	12 859,00 €	12 948,00 €	12 780,00 €	
Veselský	2/0105/11	01/2011	12/2013	Symmetry energy at super-saturation density Energia symetrie pri super-saturačnej hustote	5 737,00 €	4 632,00 €		
Svec	2/0111/11	01/2011	12/2013	Metallic materials with a complex structure Kovové materiály s komplexnou štruktúrou	23 329,00 €	20 302,00 €		
Ziman	2/0127/11	01/2011	12/2013	Testing of quantum devices Testovanie kvantových prístrojov	13 769,00 €	11 580,00 €		
Štich	2/0007/12	01/2012	12/2014	NANOCOMPSYM: Computer simulations at the na NANOCOMPSYM: Počítačové simulácie na nanoškále	14 916,00 €	11 580,00 €	11 417,00 €	
Ivančo	2/0162/12	01/2012	12/2014	Sensor properties of arranged nanoparticle layers Senzorické vlastnosti usporiadaných	8 768,00 €	9 781,00 €	9 628,00 €	

				nanočasticových vrstiev				
Vretenár	2/0190/12	01/2012	12/2014	Development of thermophysical sensors for monitoring the hardening of concrete mixtures Vývoj termofyzikýlnych senzorov na monitorovanie tuhnutia betónových zmesí		2 568,00 €	6 626,00 €	
Olejník	2/0072/13	01/2013	01/2016	Imprisonment and properties of the ground state in quantum chromodynamics and solvable models Uväznenie a vlastnosti základného stavu v kvantovej chromodynamike a v riešiteľných modeloch		4 632,00 €	2 283,00 €	4 567,00 €
Gmuca	2/0176/13	01/2013	12/2015	The stability of heavy nuclei and neutron stars Stabilita ťažkých jadier a neutrónové hviezdy		9 264,00 €	10 732,00 €	8 449,00 €
Dubnička	1/0158/13	01/2013	12/2016	Theoretical research of heavy quarkonia Teoretický výskum ťažkých kvarkónií			8 110,00 €	8 168,00 €
Venhart	2/0121/14	01/2014	12/2016	Shape coexistence in heavy atomic nuclei Tvarová koexistencia v ťažkých atómových jadrách			5 480,00 €	9 134,00 €
Švec	2/0189/14	01/2014	12/2016	New metallic materials with complex structure and exceptional volume and surface properties Nové kovové materiály s komplexnou štruktúrou a mimoriadnymi objemovými a povrchovými vlastnosťami			17 697,00 €	15 985,00 €
Filip	2/0197/14	01/2014	12/2016	Mixing of particle quantum states in external magnetic fields Kvantové zmiešavania stavov častíc v externých magnetických poliach			4 567,00 €	6 851,00 €
Šamaj	2/0015/15	01/2015	12/2017	Statistical physics of spatially bounded systems Štatistická fyzika priestorovo ohraničených				6 851,00 €

				systémov				
Štich	2/0162/15	01/2015	12/2017	Computer modeling from first principles in nanotechnology Prvoprincípové počítačové modelovanie v nanotechnológiách				11 418,00 €
Šiffalovič	2/0010/15	01/2015	12/2017	Relationship of electron transport system and structure, size and arrangement in the nanoparticle arrays for advanced gas sensors Vzťah elektrónového transportu a štruktúry, rozmerov a usporiadania v nanočasticových súboroch pre pokročilé senzory plynov				14 133,00 €
Jergel	2/0004/15	01/2015	12/2017	High-quality active surfaces for the new generation of X-ray crystal optical elements Vysoko kvalitné aktívne povrchy pre novú generáciu prvkov kryštálovej röntgenovej optiky				20 045,00 €
Reitzner	2/0151/15	01/2015	12/2017	Quantum walks and incompatibility Kvantové kráčania a nekompatibilnosť				6 469,00 €

2.3.8. Projects of SAS Centres of Excellence

SAS Centres of Excellence was a special type o projects initialized by SAS to support excellent local research teams.

Investigator	Type of project	Duration		Project title
		from	to	
Krajčí	CE SAS	08/2011	12/2014	Centre of Excellence for functionalized multi-phase materials (FUN-MAT) - Centrum excelentnosti pre funkcionalizované viacfázové materiály (FUN-MAT)
Ziman	CE SAS	02/2009	01/2013	Centre of Excellence - Quantum Technologies (QUTE) - Centrum excelentnosti – Kvantové technológie (QUTE)

2.3.9. National projects supported by EU Structural Funds

Not relevant

2.3.10. List of journals (published only in the Slovak language) edited/published by the institute:

2.3.10.1. WOS (IF of journals in each year of the assessment period)

Not relevant

2.3.10.2. SCOPUS

Not relevant

2.3.10.3. Other databases

Not relevant

2.3.10.4. Not included in databases

Not relevant

- **Position of individual researchers in an international context**

2.3.11. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

2012

prof. RNDr. Vladimír Bužek, DrSc.
sept. 2012, „On the Origin of temperature in Quantum Universe“, International Iranian Conference on Quantum Information, Teherán, Iran
28. 5. 2012, „On the Origin of temperature in Quantum Universe“, Pécs Workshop on Quantum Information and Quantum Optics, Pecs, Hungary

doc. RNDr. Emil Běták, DrSc.
3. – 7. september, 2012, „Possibilities of Statistical Pickup and Knockout in the Pre-equilibrium (exciton model) Nuclear Reactions for the Cluster Emission“, 4th International conference on Present Problems of Nuclear Physics and Atomic Energy, Kiev, Ukraina

RNDr. Mária Hartmanová, DrSc.
1. – 4. 7. 2012, „Polymorphism of Oxide Materials with Fluorite (F)-type Structure and its Utilization in Applications, 10th International Symposium on Systems with Fast Ionic Transport, Chernogolovka, Russia
5. – 8. 7. 2012, „Influence of Deposition Conditions on Electrical and Mechanical Properties of Sm2O3-Doped CeO2 Thin Films Prepared by EB-PVD (+IBAD) Methods (Indentation Hardness and Effective Elastic Modulus)“, 11th International Meeting on Fundamental Problems of Solid State Ionics, Chernogolovka, Russia

RNDr. Emília Illeková, DrSc.
22. – 23. 3. 2012, „Termická analýza kovov (Kryštalizácia a topenie amorfných kovových pások;

rozklad oxidácia a nitridácia zliatin hliníka)“, Setkání uživatel TA Instruments, Brno, Czech Republic

RNDr. Marián Krajčí, DrSc.
29. 5. – 1. 6. 2012, „Electronic Structure Of Quasicrystals: DFT Studies“, Statistical Physics and Low Dimensional Systems, SPLDS, Abbaye des Prémontrés, Pont-à-Mousson, France

prof. Ing. Štefan Luby, DrSc.
june 2012, „Iron oxide nanoparticle gas sensors“, 14th Joint Vacuum Conference, Dubrovnik, Croatia
november 2012, „Nanotechnology in medicine – some benefits and threats“, Int. Conf. Nanomedicine, University Zürich, Switzerland

RNDr. Eva Majková, DrSc.
„Self-Assembly of Noble Metal Nanoparticles at Liquid/Air Interfaces“, XI Int. Conf. on Nanostructured Materials – NANO2012, Rhodos, Greece

RNDr. Ľubomír Martinovič, CSc.
12. 12. 2012, „A consistent solution of the Schwinger model in the covariant gauge“, Light Cone 2012 II, Delhi University, India
5. 5. 2012, „New operator solution of the Schwinger model and axial anomaly“, Many manifestations of non-perturbative QCD, Caraguatatuba, Brasil

RNDr. Marek Mihalkovič, CSc.
18. – 19. 2012, „Atomistic simulations of quasicrystals“, International Symposium Quasicrystals Today, Grenoble, France

Mgr. Daniel Nagaj, PhD.
7. 11. 2012, „Hamiltonian Complexity“, workshop Tensor networks and algebraic geometry, ISI Torino, Italy

Mgr. Michal Sedlák, PhD.
13. 9. 2012, „Three aspects of quantum protocols: Extremality, Memory cost and Optimality for transformation“, COQUIT workshop, Torino, Italy

RNDr. Ladislav Šamaj, DrSc.
8. 5. 2012, „Wigner strong-coupling theory I: counterions near highly charged interfaces“, CECAM, New Challenges in Electrostatics of Soft and Disordered Matter, University of Toulouse III, France

prof. Ing. Ivan Štich, DrSc.
25. 9. 2012, „Chemical Tip Fingerprinting in Scanning Probe Microscopy of Oxidized Cu(110) Surface“, Physics Meeting in Amazonia, Belem, Brasil

Ing. Peter Švec, DrSc.
14. – 18. 2012, „Formation, structure and properties of mono, bi and tri-layered rapidly quenched ribbons“, SURFINT-SREN III Progress in Applied Surface, Interface and Thin Film Science, Florence, Italy

Ing. Peter Švec ml., PhD.
26. – 27. 1. 2012, „Nanokompozitné kovové materály pripravené žíhaním z amorfnej fázy“, seminár „TEM v materiálovém výzkumu“, VŠB-TU Ostrava

doc. Mário Ziman, PhD.
13. 9. 2012, „Direct estimation of decoherence rates“, COQUIT workshop, Torino, Italy

2013

RNDr. Eva Majková, DrSc.
21. – 23. 3. 2013, GISAXS Study of the 3-Dimensional Nanoparticle Arrays, AnalytiX2013, , Suzhou 2013, China
8. 5. 2013, E. Majkova, P. Siffalovic, K. Vegso, M. Benkovicova, M. Jergel, Self-assembly of nanoparticles at solid and liquid surfaces, Dep. of Chemistry, National Central University, 300 Chung-Da Road, Chung-Li, Taoyuan, 32054, Taiwan
20.11.2013, Nanoparticle assemblies: study and application, FME VUT Brno/ CEITEC

doc. RNDr. Emil Běták, DrSc.
07. – 11. 10. 2013, CNR-2013 (Compound Nuclear Reactions), Maresias, SP, Brazília, „Coalescence/pickup model for cluster emission“

RNDr. Stanislav Dubnička, DrSc.
17. – 24.07.2013, EPS-HEP 2013, Stockholm, „Advanced nucleon EM structure model and its predictability“

RNDr. Marián Krajčí, DrSc.
22. – 25. 09. 2013, NANOVED 2013 & NANO INFO DAY : 6th International Conference on Nanosciences, Nanotechnologies, Nanomaterials and NANO INFO DAY of the Nanoforce Project, Brno, „Surfaces of complex intermetallic compounds as selective hydrogenation calalysts“
9. – 12. 12. 2013, C-MAC Days 2013, Ljubljana, Slovenia, „Surfaces of intermetallic Ga-Pd compounds as selective hydrogenation catalysts: a DFT study“

Dr. Ing. Mgr. Andrej Liptaj, PhD.
17. – 24. 07. 2013, EPS-HEP 2013, Stockholm, „B_s meson decays in the framework of the covariant quark model“

prof. Ing. Štefan Luby, DrSc.
02. – 07. 07. 2013, NATO Advanced Study Institute Nanomaterials and Nanostructures, Cork, Little Island, „Foresight in nanotechnologies, research and perspectives“

Mgr. Daniel Nagaj, PhD.
08. 06. 2013, CEQIP 2013, Valtice, Czech Republic, „Quantum 3-SAT is QMA1-complete“
09. 12. 2013, ICTP-VAST regional school on Topological Phases and Quantum Computation, Hanoi, Vietnam, „Introduction to Quantum Computation and Complexity (5 lecture series)“

RNDr. Štefan Olejník, DrSc.
02. – 06. 09. 2013, QCD-TNT-III From quarks and gluons to hadronic matter: A bridge too far?, ECT, Trento, Italy, „Numerical study of the SU(2) Yang-Mills vacuum state: Much ado about nothing?“

RNDr. Emil Pinčík, DrSc.
16. – 19. 05. 2013, 2nd International Congress on Advanced Materials (AM2013), Zhenjiang, China: „1. Passivation of Si-based structures in KCN and HCN solutions and its Application on more types of solar cells“, „2. Aeorodynamic model of spark discharge“
8. 12. 2013 VIII international workshop on Semiconductor Surface Passivation SSP 2013, Krakow, Poland, „Passivated MOS structures of Si-based semiconductors and their comparison with HfO2/Si structures“
26. – 28. 09. 2013, BITs 3rd Annual World Congress of Nanoscience and Nanotechnology 2013, Xi an, China, „Optical properties of black silicon“
26. – 28. 09. 2013, BITs 3rd New Energy Forum – 2013, Xi an, China, „About application of passivation processes on more types of Si-based solar cells“

RNDr. Martin Plesch, PhD.
15. 11. 2013 Funding Researchers, Vilnius, PAQIT project within SoMoPro Program

RNDr. Peter Šiffalovič, PhD.

11. – 13. 09. 2013, „High-resolution Laboratory GISAXS Measurements in Direct Imaging Mode“, 5th International SAXS / GISAXS Workshop, Karlsruhe, Germany
04. – 06. 07. 2013, „X-ray analysis and applications of self-assembled nanoparticles layers“, 6th International Scientific Conference – Contemporary Materials 2013, Banja Luka, Bosna a Hercegovina
26. – 28. 09. 2013, „New non-equilibrium compression phase in the nanoparticle Langmuir film“, 3rd Annual World Congress of Nanoscience & Technology, Xi'an, China

prof. Ing. Ivan Štich, DrSc.
04. – 07. 06. 2013. „Intricate mechanism of lateral and vertical manipulation of super-Cu atoms on the Cu:O Surface: Experiment and Theory“, Physics boat workshop 2013, Helsinki
02. – 06. 12. 2013, „Magnetism and spin transport in transition metal organometallic molecules“, 5th JCS
International Symposium on Theoretical Chemistry, Nara, Japonsko,

Ing. Peter Švec, DrSc.
13. – 14. 05. 2013, „Atomic structure of quasicrystalline approximants“, Mikroskopie 2013, Lednice, Czech republic.
19. – 22. 03. 2013 „Thermal annealing of soft magnetic materials and measurements of its magnetoelastic properties“, Automatyka 2013, Warsaw

Mgr. Martin Veselský, PhD.
10. – 16. 05. 2013, „Symmetry energy and nucleon-nucleon cross sections“, Shenzhen University, Shenzhen, Čína, Národný míting pre jadrové reakcie a jadrovú spektroskopiu
31. 05. 2013 – 01. 06. 2013, „Symmetry energy and nucleon-nucleon cross sections“, National and Kapodistrian University, Athen,.Grece, 22nd Annual Symposium of the Hellenic Nuclear Physics Society

Mgr. Martin Venhart, PhD.
29. 10 – 02. 11. 2013, Spring Workshop on GEANT4, Sommerset West, South Africa, „series of talks about simulations with GEANT4“

doc. Mgr. Mário Ziman, PhD.
22. – 23. 07. 2013, Palacky University, Olomouc, „Invitation to quantum measurements“
12. 09. 2013, Technical University, Munich-Garching, „Quantum incompatibilty summary talk“, Quantum incompatibility workshop
23. 09. 2013, University of Siegen, Siegen, „Dynamics of entanglement“, Quantum Entanglement Detection 4

2014

RNDr. Stanislav Dubnička, DrSc.
27. — 31. 10. 2014, HADES Collaboration Meeting XXVIII, Bratislava, Slovakia, „Advanced model of EM structure of the ½+ octet baryon (p,n,Λ,Σ-,Σ0,Σ+,Ξ-,Ξ0)“
5. — 8. 10. 2014, 16th Small Triangle Meeting on Theoretical Physics, Ptičie, Slovakia

Ing. Matej Jergel, DrSc.
25. — 28. 4. 2014, AnalytiX 2014, Dalian, China, „Advanced V-shaped channel-cut monochromators for the extreme X-ray beam manipulation“
12. 12. 2014, 296. Rozhovory o skúmaní jemnej štruktúry materiálov ionizačným žiarením, Ústav makromolekulární chemie AV ČR, Praha, ČR, „Ex-situ a in-situ diagnostika tenkých vrstiev metodou GISAXS“

RNDr. Pavol Kalinay, CSc.
17. — 21. 3. 2014, International Workshop on Brownian Motion in Confined Geometries, Dresden, Germany, „Effective transport equations in quasi 1D systems“

prof. Ing. Štefan Luby, DrSc.

April 2014, 5th Danube Academies Conference, Chisinau, Moldova, „Prediction of the success rate of Danube Region countries new in receiving Horizon 2020 funding“
June 2014, 21. Internat. Sci. Conf. Society and Technology – Dr. J. Plenkovic, Opatija, Croatia, „Nanotechnology“
5. — 7. 11. 2014, UNESCO-MOST Conf., Bratislava, Slovakia, „Migration vs. security in Central Europe Area“

RNDr. Eva Majková, DrSc.
29. – 31. 10. 2014, Nano Science and Technology, Qingdao, China, „Time-resolved studies of colloidal nanoparticles self-assembly“

RNDr. Štefan Olejník, DrSc.
2. — 6. 12. 2014, DISCRETE 2014: Fourth Symposium on Prospects in the Physics of Discrete Symmetries, King's College, London, UK, „The Yang-Mills vacuum wave-functional thirty-five years later“

RNDr. Emil Pinčík, CSc.
18. – 20. 3. 2014, Optonika Forum 2014, Brno, Czech Republic, „Optické vlastnosti černého křemíka“

Ing. Mgr. Peter Staňo, PhD.
18. 8. 2014, SPIE NanoScience + Engineering symposium San Diego, USA, „Helical order in one dimensional semiconductors“
31. 3. 2014, DPG Tagungen, Dresden, Germany, „Spin Hot Spots in Quantum Dots“
11. 9. 2014, Nasu 4th Summer School on Semiconductor/Superconducting Quantum Coherence Effects and Quantum Information, Nasu, Tochigi, Japan, „Photon Assisted Cotunneling in Quantum Dot Spin Qubits“

RNDr. Ladislav Šamaj, DrSc.
22. — 26. 9. 2014, 2nd Workshop on Statistical Physics, Universidad de los Andes, Bogota, Columbia, 4th series of lectures „Statistical physics of integrable many-body systems“
13. — 17. 10. 2014, Workshop on optimal point configurations and applications, ESI, Vienna, Austria, „Ground state of charged particles between the walls with dielectric images“

prof. Ing. Ivan Štich, DrSc.
4. — 11. 1. 2014, CMRI International symposium, Sendai, Japan, „Simulation of superCu atom manipulation on oxidized CU(110) surface by non-contact AFM“
2. — 10. 3. 2014, American Physical Society — „Vertical NC_AFM Atom Manipulation without Tip Change“, „Spin transport throught one-dimensional transition metal organometallic cluster systems“ ; „Rigidity of the conductance of an anchored dithioazobenzene optomechanical switch“
18. 10. — 5. 11. 2014, The 3rd Global Conference on Materials Science and Engineering (CMSE 2014), Shanghai, China, „Magnetism and Spin Transport Through Transistion Metal Organometallic Molecules“
The 3M-NANO 2014 Taipei, Taiwan, „Atomic Manipulation with Dynamic AFM“
Zhongguancun Forum —„Quantum Monte-Carlo Study of Transition Metal Organometallics“; „Critical importance and Modeling of van der Waals Interactions in DFT“

Ing. Peter Švec, DrSc.
12. — 15. 5. 2014, Mechatronics 2014 – Ideas for Industrial Applications, Lodz, Poľsko, „Preparation, processing and selected properties of modern melt-quenched alloys“
24. — 28. 8. 2014, RQ15 – 15th Intl. Conf. on Rapidly Quenched and Metastable Materials, Šanghaj, Čína, „Preparation, stability and post-preparation processing of rapidly quenched monolayer, bilayer and trilayer ribbons“

RNDr. Kamil Tokár, PhD.
3. — 6. 12. 2014, 4th Workshop on ab initio phonon calculations, Institute of Nuclear Physics, Polish Academy of Sciences (IFJ PAN), Kraków, Poland, „Properties of charged organo-metallic clusters from quantum Monte Carlo method“

Mgr. Martin Veselský, PhD.
23. – 28. 9. 2014, XXI Nuclear Physics Workshop, Kazimierz Dolny, Poland, „Investigations of nuclear equation of state in nucleus-nucleus collisions and fission“
20. – 21. 6. 2014, 23rd Symposium of the Hellenic Nuclear Physics Society, Department of Physics of the Aristotle University of Thessaloniki, Greece, „Nuclear physics at the Institute of Physics of SAS in Bratislava“

doc. Mgr. Mário Ziman, PhD.
15. 6. 2014, 46th Symposium on Mathematical Physics – Information Theory & Quantum Physics, Torun, Poland, „When noise beats entanglement“

2015

RNDr. Stanislav Dubnička, DrSc.
8. — 14. 3. 2015, Excited QCD, Tatranská Lomnica, „Scalar meson f0(500) from the analysis of pion scalar form factor and the correct S-wave isoscalar pi-pi phase shift data“

Ing. Matej Jergel, DrSc.
16.9. — 23.9. 2015, Nanomaterials: Applications and Properties '2015, Ľviv University, Ukrajina, „Grazing-incidence Small-angle X-ray Scattering Technique for Probing Nanostructures and Processes at Nanoscale“
11.12. — 13.12. 2015, First International Conference on Advanced Materilas for Power Engineering, Mahatma Gandhi University Kottayam, India, „Plasmon-enhanced ITO Electrodes for the Next Generation of Organic Solar Cells without the Hole Transporting Layer“
Coauthor of 2 others talk contributions.

prof. Ing. Štefan Luby, DrSc.
16. — 17. 4. 2015, Danube Academies Conf., University Ulm, „Participation and success stories of DR countries in FP 7 security research“
28. — 30. 6. 2015, Int. Conf. Society and Technology, Opatija, „Participation of Danube region countries in FP 7 and the secure societies research“

RNDr. Eva Majková, DrSc.
24. — 26.9. 2015, 5th Annual World Congress of NanoScience and Technology, Xiian, China „In-situ GISAXS diagnostics of nanofilm and ultrashort period multilayer growth“
In-situ GISAXS diagnostics of nanofilm and ultrashort period multilayer growth, ADEPT 2015, Sorea Trigan, Strbske pleso, Slovakia

RNDr. Ľubomír Martinovič, CSc.
21. — 25.9. 2015, Light Cone 2015, INFN Frascati, Italy, „Two-dimensional massless light-front fields and solvable models“

Mgr. Daniel Nagaj, PhD.
24. 8. 2015, AQIS 2015, Seoul, South Korea, Invited tutorial „Intro to Quantum Hamiltonian Complexity“
5. 10. 2015, Workshop on Secure Quantum Computing, University of Tokyo, Tokyo, Japan, „Bombs don't explode, the forgers get rich“

RNDr. Štefan Olejník, DrSc.
2. — 5. 2. 2015, 4th Winter Workshop on Non-Perturbative Quantum Field Theory, INLN, Sophia Antipolis, France, „Measurement of the Yang-Mills vacuum wave-functional in lattice simulations“

RNDr. Ladislav Šamaj, DrSc.
5. – 6. 11. 2015, Analytical Results in Statistical Physics, Institute of Henri Poincaré, Paris, France, „Counter-ions Near a Charged Wall: Exact Results for Two-Dimensional Geometries“
24 - 25.6.2015, “Czech Workshop on Complex systems II" in Prague, Czech Republic, "Wigner ground-states of interacting charges"

prof. Ing. Ivan Štich, DrSc.
11. 12. – 21. 12.2 015, Pacifichem 2015, Honolulu, USA, „Magnetism and spin transport in 1D transition metal organometallics“
2. – 4. 12. 2015, Recent Trends in Analysis Techniques for Functional Materials and Devices, Osaka, Japan, „Atomic Force Microscopy Identification of Al.sites on Ultrathin Aluminium Oxide Film on NiAl(110)“
11. – 15. 10. 2015, 6th JCS International Symposium on Theoretical Chemistry, „Chemistry Insights into Nanomanipulation of Atoms on Surfaces: Cu and Co on Oxidized Copper Surfaces“
22. – 25. 9. 2015, 6th European Nanomanipulation Workshop, Giessen, Nemecko, „NC-AFM Manipulation of Co Atoms on Oxidized Copper Surface: Harvesting Short- and Long-Range Interactions“
28. 2. – 9. 3. 2015, American Physical Society (March meeting), San Antonio, Texas, „NC-AFM identification of different aluminium atoms on Al2O3/NiAl(110) surface“; „Quantum Monte Carlo study of charged transition-metal organometallic cluster systems“; „Switchong mechanisms and role of entropy in chemically controlled hydrazone-based switches“

Ing. Peter Švec, DrSc.
18. — 21. 5. 2015, NanoOstrava 2015, 4th Nanomaterials and Nanotechnology Meeting, VŠB-TU Ostrava, „3D nanostructured metallic materials prepared by rapid quenching”
01. — 05. 6. 2015, C-MAC Euroschool 2015. Materials Synthesis and Characterization Applied to Complex Metallic Alloys, Bratislava „Nanostructures”
13. — 17. 7. 2015, ISMANAM 2015, 22nd International Symposium on Metastable, Amorphous and Nanostructured Materials, Paris, France, „New Rapidly Quenched Alloy Systems and Their Processing”
25. — 28. 8. 2015, Magnetic Measurements 2015, Košice, Slovakia, „Universality Law in the Correlation of Magnetic Properties and Residual Stresses in Magnetic Steels”
13. — 16. 9. 2015, SMM22, Soft Magnetic Materials Conference, Sao Paulo, Brazil, „Universality of the dependence of magnetic parameters on residual stresses in steels”

Mgr. Martin Veselský, PhD.
14. – 12. 2015, SINAP-CUSTIPEN Workshop on Clusters and Correlations in Nuclei, Nuclear Reactions and Neutron Stars, Shanghai, China, „Role of equation of the state in low-energy nuclear processes.“

2.3.12. List of researchers who served as members of the organising and/or programme committees

Number of researchers in	programme committees	organising committees	organising and programme committees
2012	10	11	7
2013	7	5	14
2014	6	4	4
2015	3	7	7

Ing. Vlastimil Boháč, CSc.; Prof. RNDr. Vladimír Bužek, DrSc.; RNDr. Stanislav Dubnička, DrSc.; RNDr. Stanislav Hlaváč, CSc.;Ing. Ľudovít Kubičár, DrSc.; Prof. Ing. Štefan Luby, DrSc.; RNDr. Eva Majkova, D.Sc.;Mgr. Daniel Nagaj, PhD.; RNDr. Emil Pinčík, CSc.; RNDr. Daniel Reitzner, PhD.; prof. Ing. Ivan Štich, DrSc, ; Ing. Peter Švec, DrSc.; Ing. Peter Švec, PhD.; Mgr. Martin Venhart, PhD.; Mgr. Martin Veselsky, PhD.;doc. RNDr. Mário Ziman, PhD.;

- **Position of individual researchers in a national context**

2.3.13. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

2012

Dr. Rer. Nat. Peter Šiffalovič, PhD.
3. – 6. 9. 2012, „Nanoparticle self-assembly at solid/liquid interfaces“, 19. konferencia slovenských fyzikov, Prešovská univerzita, Prešov

Ing. Peter Švec, DrSc.
3. – 6. 9. 2012, „Formation, structure and properties of mono, bi and tri-layered rapidly quenched ribbons“, 19. konferencia slovenských fyzikov, Prešovská univerzita, Prešov
10. 5. 2012, „Recent developments in preparation and applications of amorphous alloys“, INNOVMAT ACADEMY – Progressive methods and technologies of preparation, processing and diagnostics of materials, MTF STU

2013

Mgr. Cyril Adamuščín, PhD.
30. 06. – 04. 07. 2013, HS'13, Tatranské Matliare, „Advanced nucleon electromagnetic structure model and charge proton rms radius“

Mgr. Erik Bartoš, PhD.
30. 06. – 04. 07. 2013, HS'13, Tatranské Matliare, „The advanced nucleon electromagnetic structure model and prediction of hyperon electromagnetic form factors“

RNDr. Stanislav Dubnička, DrSc.
30. 06. – 04. 07. 2013, HS'13, Tatranské Matliare, „Model independent f0(500) abd f0(980) meson parameters by pion scalar form factor analysis“

Dr. Ing. Mgr. Andrej Liptaj, PhD.
30. 06. – 04. 07. 2013, (HS'13, Tatranské Matliare) Meson decays Bs→J/ψ+η(') and B→K(*)+2v in the covariant quark model

prof. Ing. Štefan Luby, DrSc.
30. – 31. 05. 2013, „Nanotechnology in medicine, some benefits and threats“, Conf. on Emerging Ethical Issues in S&T, UNESCO/COMEST, Hotel Falkensteiner, Bratislava
14. 2. 2013, „Mission and targets of Academies of Sciences of Danube region in implementation of the EU Strategy for Danube region“, 5th Meeting of EUSDR, PA7 Steering group, Borik, Bratislava

Ing. Peter Švec, DrSc.
19. – 21. 06. 2013, „Phase mapping of iron-based rapidly quenched alloys using precession electron diffraction“, Applied physics of condensed matter (APCOM 2013), Hotel Patria, Štrbské Pleso, Slovak Republic
24. – 28. 11. 2013, „Phase and orientation mapping of fine-grained structures by precession electron diffraction“, Solid State Surface and Interface 2013 (SSSI VIII), Smolenice

2014

RNDr. Beata Butvinová, CSc.
25. — 27. 6. 2014, 20th International Conference on Applied Physics of Condensed Matter (APCOM 2014), Štrbské Pleso, „Magnetic and surface properties of Fe-Nb(Mo,V)-Cu-B-Si ribbons“

Ing. Štefan Lányi, DrSc.
2. — 5. 10. 2014, 17th School of Vacuum Technology 2014 and Course of Vacuum Technique (VT), Štrbské Pleso, „Scanning Probe Microscopy in air and vacuum“

prof. Ing. Štefan Luby, DrSc.
29. — 30. 4. 2014, Medz. konf. Sociálne posolstvo Jána Pavla II. pre dnešný svet, Univerzita ako miesto dialógu, KU Ružomberok — Poprad, „Etické implikáce nanovedy a nanotechnológií“
11. 9. 2014, Fyzika a Etika IX, Univerzita Konštantína Filozofa v Nitre, „Súčasný stav a trendy v nanoetike“

Ing. Peter Švec, DrSc.
6. — 9. 7. 2014, Colloquium of Metallurgy and Metallurgical Engineering 2014, Tále, „Rapidly quenched materials — state of the art“
25. — 27. 6. 2014, 20th International Conference on Applied Physics of Condensed Matter (APCOM 2014), Štrbské Pleso, „Ultrasensitive magnetometers based on rotational magnetic excitation“
25. — 27. 6. 2014, 20th International Conference on Applied Physics of Condensed Matter (APCOM 2014), Štrbské Pleso, „Modelling the anisotropy of magnetic field annealed Fe61Co19Si5B15 amorphous alloy“

2015

Mgr. Ján Brndiar, PhD.
8. 7. 2015, Slovak condensed matter physics workshop, Bratislava, Slovakia, „Modeling AFM microscopy for atomic-scale manipulation“

Ing. Andrej Litpaj, PhD.
7. — 10. 9. 2015, 21. konferencia slovenských fyzikov, Nitra, „ Description of decays BS → J / Ψ + η → BS and J / Ψ + η 'covariant quark model Popis rozpadov BS→J/Ψ+η a BS→J/Ψ+η' kovariantným kvarkovým modelom“

prof. Ing. Štefan Luby, DrSc.
23. — 24. 4. 2015, Konferencia 1989 a 25 rokov po..., Katolícka univerzita v Ružomberku, Poprad, „"Slovak science in the world mirror - 25 years after ...", Slovenská veda vo svetovom zrkadle — 25 rokov po...“

RNDr. Eva Majková, DrSc.
1. — 4. 6. 2015, ADEPT2015, „In-situ GISAXS diagnostics of nanofilm and ultrashort period multilayer growth“

Mgr. Michal Sedlák, PhD.
7. — 10. 9. 2015, 21. konferencia slovenských fyzikov, Nitra, „Quantum combs – formalism of general quantum protocols”

Ing. Peter Švec, DrSc.
24. — 26. 6. 2015, APCOM 2015, Štrbské Pleso, „Determination of the plastic deformation and residual stress tensor distribution using surface and bulk intrinsic magnetic properties”

2.3.14. List of researchers who served as members of organising and programme committees of national conferences

RNDr. Juraj Boháčik, CSc.; Mgr. Peter Filip, PhD.; RNDr. Dalibor Krupa, CSc., DPhil.RNDr. Eva Majkova, D.Sc.

- **Supplementary information and/or comments documenting the international and national status of the Institute**

Our employes accomplished numerous visits at research institutions in Slovakia and abroad in

order to establish or foster collaboration. During those visits lectures were usually given to demonstrate our position and results. What follows is a list of selected presentations or invited lectures given on such occasions.

List of invited/keynote presentations at research institutions

2012

Mgr. Peter Filip, PhD.
8. 12. 2012, „Career perspectives and funding of science in Slovakia“, Young Academy of Europe, Brussels, Belgium

RNDr. Marián Krajčí, DrSc.
14. 3. 2012, „On the Nobel-prize in chemistry 2011 winning topic: The discovery of quasicrystals“, zasadanie UčS, Bratislava

RNDr. Ľubomír Martinovič, CSc.
24. 4. 2012, „Light front field theory: a few non-perturbative aspects in simple terms“, ITA Sao Jose dos Campos, Brasil

RNDr. Marek Mihalkovič, CSc.
14. 12. 2012, „Atomic structure of Mg–Zn based Frank–Kasper decagonal quasicrystals“, ETH Zurich, Switzerland

Mgr. Daniel Nagaj, Phd.
25. 9. 2012, „Criticality without frustration“, IQC Colloquium, IQC Waterloo, Canada
10. 12. 2012, „Quantum computing and complexity“, Heyrovský Institute of Physical Chemistry, Prague, Czech Republic

Mgr. Peter Staňo, PhD.
24. 1. 2012, „Measuring spin currents in mesoscopic conductors“, University of Geneva, Geneva, Switzerland

prof. Ing. Ivan Štich, DrSc.
8. 8. 2012, „Quantum Monte Carlo modeling of transition metal-benzene complexes“, Centro de Investigación e Innovación Tecnológica, Instituto Politécnico Nacional, Mexico city, Mexico
28. 9. 2012, „QMC an aletrnative to DFT“, Dept. of Physics Federal University of Pará, Belem, Brasil
10. 10. 2012, „Photoswitchable molecules: from electronic structure to optomechanical switching“, Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brasil
29. 11. 2012, „Quantum Monte Carlo Modeling of π-bonded Transition-metal Organometallics“, Cavendish Laboratory, University of Cambridge, UK

2013

RNDr. Juraj Boháčik, CSc.
6. 11. 2013 Bogoliubov Institute of Theoretical Physics, Kiev, „An Analytical Formula of Propagator for An-harmonic Oscillator with Time-dependent Mas, Frequency and Coupling Constant“

RNDr. Peter Filip, PhD.
17. 10. 2013, Nuclear Science Division, Berkeley National Laboratory, „Quenching of quarkonium decay in strong electromagnetic fields“

Ing. Matej Jergel, DrSc.
12. 12. 2013, „New developments towards high-resolution GISAXS in laboratory stimulated by synchrotron studies of nanoparticle self-assembly“, MFF UK, Praha

Ing. Štefan Lányi, DrSc.

18. 12. 2013 CNR-IMM Catania, „Transient-based-analysis“

Mgr. Daniel Nagaj, PhD.
08. 01. 2013, Vienna theory lunch club, „Criticality without Frustration“
20. 01. 2013, QIP 2013, Beijing, China, „Quantum speedup by quantum annealing“
18. 03. 2013, CoQuS Colloquium, Vienna, Austria, „Quantum walks and scattering“
03. 04. 2013, ISI Torino, „Quantum walks and scattering“
05. 09. 2013, Mathematical Challenges in Quantum Information workshop, Isaac Newton Institute, Cambridge, UK, „Introduction to Quantum Complexity (2 lectures)“
25. 10. 2013, MIT Quantum Information Colloquium, Cambridge, MA, USA, „The good, bad and ugly side of Quantum Satisfiability“

RNDr. Daniel Reitzner, PhD.
09. 07. 2013, „Quantum Measurements and Joint Measurability“, TUM, München, Germany
27. 05. 2013, „Coexistence of effects and the Algebra of Two Projections“, Hannover, Germany
19. 06. 2013, „Quantum Measurements and Joint Measurability, Regensburg, Germany
05. 07. 2013, „Quantum Measurements and Joint Measurability, MPQ, München, Germany
25. 11. 2013, „Compatibility: Coexistence, Joint Measurability and the Algebra of Two Projections“, Beijing, China

prof. Ing. Ivan Štich, DrSc.
27. 06. 2013, University Regensburg, „Molecules and surfaces:DFT and quantum Monte Carlo modeling of electron energy loss spectroscopy and non-contact AFM“
29. 12. 2013, Tsukuba University, Japan, „Molecular magnets and spin filters: QMC study of transition metal-based organometallics“

Mgr. Martin Venhart, PhD.
05. 11.2013, University of Stellenbosch, South Africa, „Simulation of summing effects in complex decay schemes using GEANT4“
04. 11.2013, iThemba Labs, South Africa, „Nuclear Structure of Odd-Au Isotopes“

Mgr. Martin Veselský, PhD.
09. 12. 2013, „How do the fission barriers of exotic nuclei really look like?“, Flerov Laboratory of Nuclear Reactions, Dubna, Russia

doc. Mgr. Mário Ziman, PhD.
31. 01. 2013, University of Vienna, Vienna, „Direct estimation of decoherence rate“
30. 05. 2013, Institute of mathematics SAS, Bratislava, „Entanglement-annihilating channels“
28. 11. 2013, Palacký University, Olomouc, „Entanglement-annihilating vs. entanglement breaking“

2014

prof. Ing. Štefan Luby, DrSc.
March 2014, University of Bielefeld, Germany, „Foresight in nanoscience and nanotechnology – reserach and perspectives“

RNDr. Ľubomír Martinovič, CSc.,
15. 5. 2014, Department of Physics and Astronomy, Iowa State University, Ames, Iowa, USA, „Exactly solvable models and their physical vacua“

RNDr. Daniel Reitzner, PhD.
5. 3. 2014, City University of New York, Hunter College, USA, „Fault-ignorant Quantum Search“
20. 11. 2014, Charles University Prague, Faculty of Mathematics and Physics, Czech Republic, „From Quantum Cloning to Superluminal Communication“
3. 12. 2014, Masaryk University, Brno, Faculty of Informatcs, Czech Republic, „Compatibility as a Resource in CHSH-type Inequalities“

Ing. Mgr. Peter Staňo, PhD.
29. 7. 2014, Department of Physics, University of Basel, Switzerland, „Fast Long-Distance Control of Spin Qubits by Photon Assisted Cotunneling“
18. 3. 2014, Department of Physics, University of Regensburg, Germany, „Helical order in one dimensional semiconductors“

Mgr. Martin Veselský, PhD.
25. 11. 2014, Institute of Nuclear and Particle Physics, Astronomy and Cosmology (INPAC) at Shanghai Jiao Tong University, China, „Investigations of nuclear equation of state in nucleus-nucleus collisions and fission“

2015

RNDr. René Derian, PhD.
1. – 5. 6. 2015, Univerzity Regensburg, Regensburg, Germany, „Towards sub-chemical accuracy description of non-covalent interaction using Quantum Monte Carlo“

Mgr. Peter Filip, PhD.
19. 6. 2015, University of Stony Brook, New York, USA, „Modification of Hadron Decayss in Strong Magnetic Field“

prof. Ing. Štefan Luby, DrSc.
29. 10. 2015, Symposium at the 100th anniversary of J. Pócza, Inst. for Technical Physics and Material Research, Hungarian Academy of Sciences, Budapest, „From thin films to nanoparticle layers“

Mgr. Daniel Nagaj, PhD.
5. 2. 2015, University of Freiburg, Germany, „Local Tests of Global Entanglement and a Counterexample to the Generalized Area Law“
23. 2. 2015, Perimeter Institute, Waterloo, Canada, „Local Tests of Global Entanglement and a Counterexample to the Generalized Area Law“
5. 5. 2015, Leibniz Universitaet Hannover, Germany, „Quantum walks and scattering“
13. 5. 2015, Niels Bohr Institute, Copenhagen, Denmark, „An adaptive attack on Wiesner's quantum money“

prof. Ing. Ivan Štich, DrSc.
15. – 19. 6 . 2015, 25. – 26. 6. 2015, CBPF: CEntro Brasileiro de Pesquisas Físicas, Rio de Janerio, Brazilia, „NC-AFM Manipulation of Co Atoms on Oxidized Copper Surfaces: Harvesting Short- and Long-Range Interactions“; „QMC Study of Transition Metal Organometallics“

2.4. Tables of project structure, research grants and other funding resources

- **International projects and funding**

2.4.1. Major projects within the European Research Area and other important project – Framework Programmes of the EU, ERA-NET, European Science Foundation, NATO, COST, INTAS, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I"),

	Project title	Typ / Project number	Duration in months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Koloidné aspekty nanovied pre inovatívne procesy a materál/ Collodial Aspects of Nanoscience for Innovative Processes and Materials	SAS COST CM1101	1/2012 – 1/2016	12 000,00 €	W - Majková
	Fundamentálne problémy kvantovej fyziky/ Fundamental problems in Quantum physics	SAS COST MP1006	4/2011-3/2015	13 000,00 €	W - Ziman
	Pokročilé metódy a prvky pre rtg metrológiu/ Advanced X-ray spatial and temporal metrology	SAS COST MP1203	11/2012 – 11/2016	13 333,00 €	C - Jergel
	Kvantovo-informatické technológie využívajúce previazanie (QUIE2T)/ Quantum Informmation Entanglement-Enabled Technologies	SAS FP7 - Cooperation	2/2010-7/2013	16 761,00 €	C - Bužek
	Kvantové rozhrania, senzory a komunikácia založené na previazaní (Q-ESSENCE)/ Quantum Interfaces, Sensors and Communication based on Entanglement	SAS FP7 - Cooperation	2/2010-4/2013	4 600,00 €	C - Bužek
	Príprava a štúdie nanočasticových súborov pre plazmonické aplikácie/ Preparation and studies of nanoparticle arrays for plasmonic applications	SAS - NSC TAIWAN	1/2012 – 12/2014	47 500,00 €	C - Majková
	Kvantovo-informatické technológie využívajúce previazanie (QUIE2T)/ Quantum Informmation Entanglement-Enabled Technologies	FP7 - Cooperation ICT	2/2010-7/2013	650 000,- €	C - Bužek
	Termodynamika v kvantovom režime/ Thermodynamics in Qiantum Regime	SAS COST MP1209	5/2013-4/2017	10 600,00 €	C - Bužek
	Zlepšená rekonštrukcia v rtg tomografii: experiment, modelovanie, algoritmy Enhanced X-ray Tomographic Reconstruction: Experiment, Modeling, and Algorithms	SAS COST MP1207	5/2013 – 5/2017	4 000,00 €	C - Šiffalovič
	Simulators and Interfaces with Quantum Systems (SIQS)	SAS FP7 - Cooperation	5/2013-4/2016	10 667,00 €	C - Bužek
	Kvantové technológie pre Európu (QUTE-Europe)/ Quantum Technologies for Europe	SAS FP7 - Cooperation	2/2013-1/2016	55 417,00 €	C - Bužek
	K nízkonákladovej vysoko účinnej organickej fotovoltike na báze polymérov s použitím grafénu a nanočastíc vzácnych kovov/ Towards low-cost and highly efficient polymer-based organic photovoltaics via Incorporation of graphene and noble metal nanoparticles	JRP SAS - TUBITAK	9/2013 – 8/2016	54 167,00 €	C- Majková

	Detekcia malých magnetických polí pomocou fyzikálne spracovaných rýchlochladených zliatin (FX-GATEX)/ Physically processed rapidly quenched alloys for detection of low magnetic fields	JRP SAS - TUBITAK	11/2013-10/2016	52 000,00 €	C - Švec
2013	Pokročilý výskum povrchov a povlakov pre nastupujúcu generáciu RTG difrakčnej optiky (XOPTICS)/ Surface engineering and advanced coatings for the next generation of X-ray diffractive optics	SAS M-ERA.Net	9/2013 – 8/2016	58 300,00 €	C - Šiffalovič
	Kvantové technológie pre Európu (QUTE-Europe)/ Quantum Technologies for Europe	FP7 - Cooperation 600788	2/2013-1/2016	426 900,00 €	C - Ziman
	Simulators and Interfaces with Quantum Systems (SIQS)	FP7 - Cooperation 600645	5/2013-4/2016	133 334,00 €	W -Bužek
2014	Nanoscale Quantum Optics	SAS COST MP1403	12/2014-11/2018	4 000,00 €	W - Bužek
	Stabilizovaná fotovoltika ďalšej generácie (StableNextSol)/ Stable Next-Generation Photovoltaics: Unravelling Degradation Mechanisms of Organic Solar Cells by Complementary Characterization Techniques	SAS COST MP1307	4/2014 – 4/2018	3 666,00 €	Majková
2015	CEMEA Building-up Centre of Excellence for advanced materials application	H2020-WIDESPREAD-2014-1-FPA	1/2015-12/2016		I-Majková
	Nové magnetické materiály na báze mangánu s výmennou interakciou (NEXMAG)/ New Exchange-Coupled Manganese-Based Magnetic Materials	SAS M-ERA.Net	10/2015-9/2018	6 250,00 €	W -Švec
	Hybridný integrovaný klaster pre generovanie elektrickej energie vrátane obnoviteľných palív (HELENIC)/ Hybrid Electric Energy Integrated Cluster concerning Renewable Fuels	SAS H2020 RIA	6/2015-5/2018	2 333,00 €	C- Švec
	Hybridný integrovaný klaster pre generovanie elektrickej energie vrátane obnoviteľných palív (HELENIC)/ Hybrid Electric Energy Integrated Cluster concerning Renewable Fuels	H2020 FET 665318	06/2015-05/2018	444 000,- €	W - Švec

2.4.2. Other international projects, incl. total funding and funding for the institute

1. Collaboration CERN-ISOLDE, CERN, Geneva. Total yearly funding for the Institute
   a) From Ministry of Education, Slovak republic 5000 $/year
   b) From ISOLDE funds 15000 SFR/year
   Total funding 2012-2015 20000 $, 60000 SFR
2. Theoretical studies of heavy exotic hadrons within relativistic quark model, JINR Dubna, JINR Grant, funding 2012-2015, 34720 €
3. Synthesis and Properties of Nucleus at the Stability Limit, JINR Dubna, JINR Grant, funding 2012-2015, 113982 €
4. Study of Polarization Phenomena and Spin Effects at the JINR NUCLOTRON-M Facility, JINR Dubna JINR Grant, funding 2012-2015, 62870 €

2.4.3. Other important, international projects and collaborations without direct funding (max. 10 projects)

1. HADES Collaboration, GSI Darmstadt
5. Nuclear Reaction Data Center Network, NDS IAEA Vienna, OECD-NEA Data Bank Paris, NNDC BNL Brookhaven, CJD Obninsk

- **National projects and their funding**

2.4.4. Projects supported by the Slovak Research and Development Agency (APVV)

Role of the Institute e.g. coordinator “C”, investigator “I”.

Year	Project title	Typ / Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Complexity of quantum information/ Komplexnosť kvantovej informácie	APVV-0646-10	5/2011-10/2014	135 035,00 €	C-Ziman
	Study of rocks properties and investigation of structural and textural characteristic in correlation with thermophysical and physico-mechanical properties/ Štúdium vlastností hornín a vyšetrovanie štruktúrno-textúrnych charakteristík hornín s koreláciou na termofyzikálne a fyzikálno-mechanické vlastnosti	APVV-0641-10	5/2011-10/2014	248 476,00 €	C-Boháč
	Application of advanced metallic materials for stiffness enhancement of lightweight structural components/ Zvyšovanie tuhosti ľahkých konštrukčných prvkov aplikáciu nových kovových materiálov	APVV-0647-10	5/2011-10/2014	100 000,00 €	W-Švec
	Physics of quantum walks/ Fyzika kvantových kráčaní	SK-PT-0008-10	1/2011-6/2012	5 400,00 €	I/Reitzner
	Role of defects in organic semiconductors for solar cells/ Úloha defektov v organických polovodičoch pre slnečné články	APVV-0096-11	7/2012-12/2015	248 710,00 €	C-Nádaždy
	Study of crystal structure and thermodynamic properties of aluminum-base and zinc-base complex metallic alloys/ Štúdium kryštálovej štruktúry a termodynamických vlastností komplexných kovových zliatin na báze hliníka respektíve zinku	APVV-0076-11	7/2012-12/2015	248 988,00 €	I-Švec
	Nanocrystalline and quasicrystalline metallic systems with tailored structure and morphology/ Nanokryštalické a kvázikryštalické kovové systémy s cielene modifikovanou štruktúrou a morfológiou	APVV-0492-11	7/2012-12/2015	243 883,00 €	C-Švec
	Symmetry energy at spuer-saturation density/ Energia symetrie v štruktúre jadrovej hmoty	APVV-0177-11	7/2012-12/2015	203 750,00 €	C-Venhart

	Strongly Interacting Matter under Extreme Conditions/ Silno integrujúca hmota v extrémnych podmienkach	APVV-0050-11	7/2012-12/2015	114 344,00 €	C-Olejník
	Research of New Passivation Processes of Si-based Structures/ Výskum nových pasivačných procesov štruktúr na báze kremíka	APVV-0888-11	7/2012-8/2015	249 512,00 €	C-Pinčík
	NANOTIP: Tip-induced SPM processes: Imaging and nanomanipulation/ SPM procesy indukované hrotom: zobrazovanie a nanomanipulácia	APVV-0207-11	7/2012-12/2015	197 524,00 €	C-Štich
	Crystal elements of X-ray optics for beam compression and expansion/ Kryštálové prvky rtg opriky pre kompresiu a expanziu zväzku	APVV-0308-11	7/2012-12/2015	200 000,00 €	C-Jergel
	nanoQMC: Quantum Monte-carlo for nanoparticles and transport/ Kvantové Monte-Carlo pre nanočastice a transport	APVV-LPP-0392-09	1/2010-12/2013	83 000,00 €	C-Štich
	Microstructure of Fe-Al based alloys/ Mikroštruktúra zliatin na báze Fe-Al	APVV SK-CZ-0096-11	1/2012-12/2013	2 178,00 €	C-Maťko
	Metal tapes for magnetic sensors Kovové pásky pre magnetické senzory	APVV SK-CZ-0078-11	1/2012-12/2013	3 932,00 €	C-Butvin
2013	Quantum Information of Many Body Systems/ Kvantová informácia mnohočasticových systémov	APVV-0808-12	10/2013-9/2017	151 138,00 €	C-Bužek
	Progressive nanocrystalline and amorphous materials for application in selected high-power electronic devices/ Progresívne nanokryštalické a amorfné materiály pre aplikáciu vo vybraných špičkových zariadeniach výkonovej elektroniky	APVV-0460-12	10/2013-9/2016	55 500,00 €	W - Švec
	Study of hadron structure and the test of Standard Model with the more precise evaluation of QED running coupling constant at M_Z and the muon g-2 anomaly/ Výskum štruktúry hadrónov a previerka Štandardného modelu presnejším vyhodnotením bežiacej väzbovej konštanty QED v M_Z a miónovej g-2 anomálii	APVV-0463-12	10/2013-9/2017	115 040,00 €	C-Dubnička
	The functional properties of the new amorphous andnanocrystalline magnetic materials Funkčné vlastnosti nových amorfných a naokryštalických magnetických materiálov	APVV SK-PL-0043-12	1/2013-12/2014	3 600,00 €	C-Švec
2014					
2015	Nanoparticles-based sensors of	APVV-14-0891	7/2015-6/2019	235275,00 €	C-Ivančo

	gaseous biomarkers of diseases/ Nanočasticové senzory pre plynné biomarkery chorôb				
	Quantum theory on graphs and networks/ Kvantová teória grafov a sietí	APVV-14-0878	7/2015-6/2019	152536,00 €	C-Ziman
	Efficent preparation of powdered magnesium hydrid directly from the magnesium melt/ Ekonomická príprava práškového hybridu horčíka z roztaveného horčíka	APVV-14-0934	7/2015-6/2018	10000,00 €	I-Švec
	Research of the nanomachining technology for active surfaces of the new generation of the X-ray optics/ Výskum technológie nanoobrábania pre aktívne povrchy novej generácie RTG optiky	APVV-14-0745	7/2015-6/2018	250000,00 €	C-Majková
	Graphene-based nanoplatform for detection of cancer/ Grafénová nanoplatforma na detekciu rakoviny	APVV-14-0120	7/2015-6/2018	49891,00 €	I-Šiffalovič
	Surface and Bulk Defect States Analysis Using Capacitance Microscopy-Based Methods/ Analýza povrchových a objemových stavov s použitím metód na báze kapacitnej mikroskopie	SK-HU-2013-0031	1/2015-12/2016	1950,00 €	C-Lányi

2.4.5. Projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

VEGA	2012	2013	2014	2015
Number	27	28	26	24
Funding in the year (EUR)	157687	144185	129109	142894

[1]

[1] Excluding projects for the popularisation of science

- **Summary of funding from external resources**

2.4.6. List of projects supported by EU Structural Funds

Investigator	Project number (ITMS)	Duration		Project title	Acronym
		from	to		
C - Majková	26240220011	10/2009	09/2012	Centre for Applied Research of nanoparticles/ Centrum aplikovaného výskumu nanočastíc	CAVN
I - Majková	26240220006	10/2009	05/2013	Center for knowledge marketing and intellectual property rights of the Slovak Academy of Sciences/ Centrum komercializácie poznatkov a ochrany duševného vlastníctva Slovenskej akadémie vied	CEKOODUV
I - Majková	26240120011	02/2010	01/2013	Building a Center of Excellence for New Technologies in Electrical Engineering - II . phase/ Budovanie Centra excelentnosti pre nové technológie v elektrotechnike – II. etapa	CENTE II
C - Štich	26240120022	03/2010	02/2013	Centre of Excellence of Quantum Technologies/ Centrum excelentnosti kvantových technológií	meta-QUTE
C - Plesch	26110230006	04/2010	03/2013	PhD Education Center - education based on scientific knowledge/ Centrum rozvoja doktorandov - vzdelávanie založené na vedeckých poznatkoch	CRD
I - Majková	26240220028	05/2010	05/2013	Effective management of production and consumption of energy from renewable sources/ Efektívne riadenie výroby a spotreby energie z obnoviteľných zdrojov	ENERGOZ
I - Švec	26240120020	07/2010	06/2014	Center of excellence for research and development of composite materials for engineering , construction and medical applications - II . phase/ Centrum excelentnosti na výskum a vývoj konstrukčných kompozitných materiálov pre strojárske, stavebné a medicínske aplikácie - II. etapa	CEKOMAT II
C - Šiffalovič	26240220047	09/2010	08/2013	Applied research of advanced photovoltaic cells/ Aplikovaný výskum pokročilých fotovoltaických článkov	FOTOVOLTIKA
I - Majková	26220220150	12/2010	12/2014	Research Center for Light and lighting equipment/ Výskumné Centrum svetla a svetelnej techniky	OMS Dojč
I - Gmuca	26220220147	02/2011	01/2015	Industrial research center of security risks of loss of coolant accidents in nuclear power plants/ Priemyselné výskumné centrum bezpečnostných rizík havárií so stratou chladiva v jadrových elektrárňach	PVC HAJE

I - Majková	26240220073	08/2011	11/2014	The competence center for new materials, advanced technologies and energy/ Kompetenčné centrum pre nové materiály, pokročilé technológie a energetiku	KCMTE
I - Jergel	26220220170	06/2012	11/2014	Research and development center for advanced X-ray technology/ Výskumno-vývojové centrum pre pokročilé rtg technológie	RTG TECH
C - Hlaváč	26210120023	11/2012	11/2015	Completion of IoP SAS infrastructure in research and diagnostic of nanoparticles, nanomaterials and materials using methods of nuclear physics/ Dobudovanie infraštruktúry FÚ SAV v oblastiach výskumu a diagnostiky nanočastíc, nanomateriálov a materiálov s využitím metód jadrovej fyziky	INFRA FÚ SAV
I - Majková	26240220088	09/2013	08/2015	Center for applied research of new materials and technology transfer/ Centrum aplikovaného výskumu nových materiálov a transferu technológií	CAVNMaTT
I - Hlaváč	26220220198	09/2014	08/2015	ALLEGRO Research Center/ Výskumné centrum ALLEGRO	ALLEGRO

2.4.7. Summary of external resources of the EU Structural Funds (ERDF/ESF)

Role of the Institute in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”.

Year	Project title	Project number	Duration in months	Funding for the Institute (EUR)	Total budget	Role of the Institute
2012	Center for knowledge marketing and intellectual property rights of the Slovak Academy of Sciences/ Centrum komercializácie poznatkov a ochrany duševného vlastníctva Slovenskej akadémie vied CEKOODUV	26240220006	43	3 300,00	497 776,50	C
	Center of excellence for research and development of composite materials for engineering , construction and medical applications - II . phase/ Centrum excelentnosti na výskum a vývoj konstrukčných kompozitných materiálov pre strojárske, stavebné a medicínske aplikácie - II. etapa	26240120020	47	165 420,00	2 648 620,21	I
	Applied research of advanced photovoltaic cells/ Aplikovaný výskum pokročilých fotovoltaických článkov	26240220047	35	939 740,40	939 740,40	C
	PhD Education Center - education based on scientific knowledge/ Centrum rozvoja doktorandov - vzdelávanie založené na vedeckých poznatkoch	26110230006	35	324 000,00	324 000,00	C
	Centre of Excellence of Quantum Technologies/ meta-QUTE Centrum excelentnosti kvantových technológií	26240120022	35	580 058,48	2 648 257,00	C
	Effective management of production and consumption of energy from renewable sources/ Efektívne riadenie výroby a spotreby energie z obnoviteľných zdrojov	26240220028	36	131 541,00	5 987 816,00	I
	Research Center for Light and lighting equipment/ Výskumné Centrum svetla a svetelnej techniky	26220220150	48	851 640,33	2 797 696,33	I
	Industrial research center of security risks of loss of coolant accidents in nuclear power plants/ Priemyselné výskumné centrum bezpečnostných rizík havárií so stratou chladiva v jadrových elektrárňach	26220220147	47	1 360 100,00	3 328 352,80	I

	The competence center for new materials, advanced technologies and energy/ Kompetenčné centrum pre nové materiály, pokročilé technológie a energetiku	26240220073	39	300 000,00	7 496 037,80	I
	Completion of IoP SAS infrastructure in research and diagnostic of nanoparticles, nanomaterials and materials using methods of nuclear physics/ Dobudovanie infraštruktúry FÚ SAV v oblastiach výskumu a diagnostiky nanočastíc, nanomateriálov a materiálov s využitím metód jadrovej fyziky	26210120023	17	2 997 825,00	2 997 825,00	I
	Research and development center for advanced X-ray technology/ Výskumno-vývojové centrum pre pokročilé rtg technológie	26220220170	29	534 150,00	2 190 210,00	I
	Building a Center of Excellence for New Technologies in Electrical Engineering - II . Phase/ CENTE II - Budovanie Centra excelentnosti pre nové technológie v elektrotechnike II. etapa	26240120019	35	395 452,66	2 646 536,12	I
	Building a Center of Excellence for New Technologies in Electrical Engineering - II . phase/ Centrum aplikovaného výskumu nanočastíc	26240220011	35	321 644,00	494 465,00	C
2013	Center for applied research of new materials and technology transfer/ Centrum aplikovaného výskumu nových materiálov a transferu technológií	26240220088	23	109 739,40	24 879 433,75	I
2014	ALLEGRO Research Center/ Výskumné centrum ALLEGRO	26220220198	11	66 993,00	16 214 711,54	I
2015						

External resources	**2012**	**2013**	**2014**	**2015**	**total**	**average**
External resources (milions of EUR)	1.055	1.256	3.147	1.473	**6.931**	**1.733**
External resources transfered to coooperating research institute (milions of EUR)					**0.000**	

- **Supplementary information and/or comments on research projects and funding sources**

2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity

Accredited programme	Period of validity (years)
Theoretical and mathematical physics / Teoretická fyzika a matematická fyzika	internal: 4
	external: 5
Physics of condensed matter and acoustics / Fyzika kondenzovaných látok a akustika	internal: 4
	external: 5
Quantum electronics and optics and optical spectroscopy / Kvantová elektronika a optika a optická spektroskopia	internal: 4
	external: 5
Nuclear and sub-nunclear physics / Jadrová a subjadrová fyzika	internal: 4
	external: 5
Physical engineering / Fyzikálne inžiniertstvo	internal: 3
	external: 4

2.5.2. Summary table on doctoral studies (number of internal/external PhD students; number of foreign PhD students, number of students who successfully completed their theses, number of PhD students who quit the programme*)*

PhD study	12/31/2012			12/31/2013			12/31/2014			12/31/2015		
Number of potential PhD supervisors	50			52			51			50		
PhD students	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted
Internal	12.0	5.0	5.0	12.0	5.0	5.0	13.0	1.0	2.0	15.0		
External	1.0			1.0			2.0			2.0		
Other supervised by the research employees of the institute	0.0			0.0			0.0			0.0		

2.5.3. Summary table on educational activities [2]

Teaching	2012	2013	2014	2015
Lectures (hours/year)[2]	372	338	252	175
Practicum courses (hours/year)[2]	79	166	94	51
Supervised bachelor theses (in total)	8	7	3	2
Supervised diploma theses (in total)	8	8	4	2
Supervised PhD theses (in total)	11	17	12	10
Members in PhD committees (in total)	7	6	7	8
Members in DrSc. committees (in total)	0	1	1	2
Members in university/faculty councils (in total)	1	1	1	1
Members in habilitation/inauguration committees (in total)	2	3	2	2

2.5.4. List of published university textbooks

Not relevant

2.5.5. Number of published academic course books

Not relevant

2.5.6. List of joint research laboratories/facilities with universities

1. Laboratory of quantum measurements, common laboratory of Faculty of Mathematics, Physics and Informatics, Comenius university and IoP, located at IoP
2. Laboratory of ultrafast laser photonics, common laboratory of International Laser Center (ILL (Comenius university, STU), located at Faculty of Natural Sciences, Comenius University

- **Supplementary information and/or comments on doctoral studies and educational activities**

  Policy of Institute of Physics is to encourage our doctoral students to complete part of the studies in high ranking laboratories abroad. We are succesfull in majority of cases and our students take part or perform experiments at European Large Scale Facilities. After finishing PhD studies, many of our students got a postdoc position abroad and several of them found a job in local industry. During the evaluation period we had 4 foreign students.

2.6. Societal impact

2.6.1. List of the most important results of applied research projects. Max. 10 items

1. Within collaboration with with EVPU two new nanocrystalline soft magnetic systems – Fe/Co-Si-B-C-Cu-P (Nanomet-type) and Fe/Co-Sn-B were designed and developed, both without use of critical raw materials (Nb, Zr), with high saturation magnetization and high operating temperatures.

[2] Do not include time spent with bachelor, diploma or PhD students during their supervising

2. Technology of cut-core soft magnetic nanocrystalline circuits using Finemet-type alloys was used in design and development of components of magnetic circuits, which will be supplied as parts of traction vehicles, stabilized power supplies for synchrotrons, etc., in collaboration with EPVU, jsc, Nová Dubnica
3. New-type monolithic X-ray monochromators with added functionality of the beam compression and beam expansion for X-ray metrology and X-ray imaging, respectively, were developed and prepared in collaboration with Integra, TDS, jsc, Piešťany, Slovakia.
4. Plasmon-enhanced front electrodes without a hole transport layer for organic solar cells were designed and successfully tested, allowing increase of the power conversion efficiency by up to 20%.
5. Anti-reflective superhydrophobic coatings with self-cleaning and anti-icing functionalities were developed and succesfully tested on organic solar cells for operation in real open-air conditions. As a bonus, 6% increase of the power conversion efficiency was achieved.
6. New hybride luminophores with ZnCdSeS quantum dots for generation of the red part of spectrum for white LED diodes were developed in collaboration with OMS,jsc, Dojč.
7. Gas sensors for explosive detection and environment monitoring based on semiconducting iron oxide and cobalt oxide nanoparticles were developed with sensitivity down to ppm (H_2) and ppb (NO_x) ranges.
8. Single-point diamond turning technology for finishing active surfaces of high-end X-ray diffractive optics providing unprecedent surface quality unattainable by conventional techniques was developed in collaboration with Integra, TDS, s.r.o. company, Piešťany, Slovakia, tortuetec GmbH., Vienna, Austria, and Technodiamant B.V., Almere, The Netherlands. A local surface roughness of 0.1 nm and planarity (figure error) of 10^{-5} has been achieved so far.
9. As a spin-off of previous research projects studying thermophysical and physico-mechanical properties of rock and structural materials, special sensors and devices using wireless data transmission for measurement of moisture and thermal conductivity of structural materials were developed. These sensors are used for long term assessment of state of several important objects of cultural heritage. In collaboration with Monuments Board of Slovak republic and Parochial Office of Bratislava Old Town, long term monitoring of temperature-moisture regime of Spiš Castle belonging to UNESCO World Cultural Heritage, St. James's Church in town of Levoča and tower of St. Martin's cathedral in Bratislava is carried on.

2.6.2. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes

Not relevant

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues

1. APVV-460-12, Progressive nanocrystalline and amorphous materials for applications in selected high-end power electronic devices. Joint applied research project with EPVÚ, jsc., Dubnica as coordinator**.**
2. ITMS: 26220220147, Industrial research center of security risks of loss of coolant accidents in nuclear power plants, Joint applied research project with VÚEZ, jsc,Levice
3. Surface engineering and advanced coatings for the next generation of X-ray diffractive optics, M-ERA.Net XOPTICS, 2013–2016 (industrial partners Integra TDS jsc.., Piešťany, Slovakia, and Tortuetec GmbH., Vienna, Austria), revenue 75 000 €
4. Research and Development Centre for Advanced X-ray Technologies, ASFEU MŠ SR, ITMS 26220220170, 2012–2014 (industrial partner Integra TDS jsc.., Piešťany, Slovakia). 454 027,50 €
5. Crystal elements of X-ray optics for beam compression and expansion, APVV-0308-11, 2012–2014 (industrial partner Integra TDS jsc., Piešťany, Slovakia), 200 000 €

6. Competence Centre for New Materials, Advanced Technologies and Energetics, ASFEU MŠ SR, ITMS 26240220073, 2011–2014 (7 industrial partners from Slovakia) , 40 000EUR
7. Research Centre of Light and Light Technique, ASFEU MŠ SR, ITMS 26220220150, 2011–2014 (industrial partner OMS jsc.Dojč)., 350 000EUR
8. APVV-0641-10 Study of rocks properties and investigation of structural and textural characteristic in correlation with thermophysical and physico-mechanical properties. Several hot ball sensors delivered to Building Physics Section, Department of Civil Engineering, KU Leuven, Belgium

2.6.4. List of licences sold abroad and in Slovakia, incl. revenues

Not relevant

2.6.5. List of most important social discourses under the leadership or with significant participation of the institute (max. 10 items)

Not relevant

2.6.6. Summary of relevant activities, max. 300 words

Given the structure of Slovak industry dominated by big foreign companies performing research and development in their home countries, it is difficult to find competent industrial partner. Nevertheless, most promising potential for application of our research results has research related to material science. Our results in very specific field of X-ray optics led to development of components used by prominent European company producing measuring instruments. Novel magnetic materials will probably find broader application in electrotechnical industry and will help to reduce energy consumptions of numerous devices. Another results contribute to completely different field of our society and may help in conservation of our cultural-built heritage.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

1. Popularising books and articles on science (Annex No. 1)
2. An annual *Doors Open Days*
3. An annual participation on *Science and Technology Week in the Slovak Republic*
4. The participation at *The festival of science - Researchers' Night*
5. *"Young Physicists´Tournament"* - team-oriented competition between secondary school students *(*http://www.tmfsr.sk/ *)*

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2012	2013	2014	2015	total
Articles in press media/internet popularising results of science, in particular those achieved by the Institute	6	11	6	12	35
Appearances in telecommunication media popularising results of science, in particular those achieved by the Institute	4	1	1	6	12
Public popularisation lectures	33	19	27	9	88

- **Supplementary information and/or comments on popularisation activities max. 300 words**

Project	Project title	Funding for Institute	Investigator
LPP-0084-09	Physics through the eyes of physicists	66 399,00	Plesch

2.8. Background and management. Human resources and implementation of recommendations from previous assessment

2.8.1. Summary table of personnel

Personnel	2012	2013	2014	2015
All personnel	119.0	116.0	110.0	110.0
Research employees from Tab. Research staff	100.0	98.0	94.0	95.0
FTE from Tab. Research staff	66.060	66.290	66.890	67.960
Average age of research employees with university degree	49.3	49.4	49.0	50.0

2.8.1.1. Professional qualification structure (as of 31.12. 2015) FEMALE

FEMALE	AGE								
Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.									1
II.a / Assoc. prof.								2	
Other researchers PhD./CSc.		1							
doc. / Assoc. prof.									

2.8.1.2. Professional qualification structure (as of 31.12. 2015) MALE

MALE	AGE								
Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.					1		3	4	7
II.a / Assoc. prof.		3	7	4	3	4	6	2	3
Other researchers PhD./CSc.	1	9	11	6	2	5	7	3	4
doc. / Assoc. prof.			2		1				1

2.8.2. Postdoctoral and mobility scheme

2.8.2.1. Postdoctoral positions supported by national and international resources

Postdoctoral positions within LPP programme are supported by national funding agency Slovak Research and Development Agency.

Project	Project title	Investigator	Fellows	Duration
7th FP IP 2010-248095	**Q**uantum Interfac**ES**, **SEN**sors, and **C**ommunication based on **E**ntanglement (QESSENCE)	Bužek	Dr.Stefano Fachcini	11/2011-4/2012
LPP-0175-09	Self-assembly of nanoparticles and molecules at the liquid-air interface Samousporiadanie nanočastíc a molekúl na rozhraní kvapalina/vzduch	Majkova	Martin Weis	2009 - 2012
LPP-0392-09	nanoQMC: Quantum Monte Carlo for nanoparticles and quantum transport Kvantové Monte-Carlo pre nanočastice a kvantový transport	Štich	Lucia Horváthová	2009 - 2012
LPP-0430-09	QWAC - Quantum walks and complexity Kvantové kráčania a zložitosť	Bužek	Daniel Nagaj	2009 – 2012
LPP-0442-09	The role of water in porous structures	Kubičár	Danica Fridríková	2009 – 2012

	Úloha vody v poréznych štruktúrach			

2.8.2.2. Postdoctoral positions supported by external funding

SAIA Grants, Slovak Academic Information Agency, n.o. is a nonprofit organization fostering international academic collaboration, it supports mainly short term stays up to maximum 12 months. Stays under other programmes are mostly covered by guest's home institutions or IAESTE.

Name	Surname	Country	Begining of the stay	Duration in month
The National Scholarship Programme of the Slovak Republic				
Taras Stepanovych	Kavetskyy	Ukraine	01.11.2012	6
Sergey	Philippov	Russian Federation	01.12.2012	12
Yuriy	Plevachuk	Ukraine	04.02.2013	2
Andrey	Stepanov	Russian Federation	15.04.2013	1
Dmytro	Kostiuk	Ukraine	01.09.2013	3
Evangelos	Hristoforou	Greece	01.02.2014	10
Radoslaw Zbigniew	Strzalka	Poland	01.10.2016	4
Teiko	Heinosaari	Finland	01.01.2015	8
Iaryna	Lytvynenko	Ukraine	01.02.2015	5
Yuriy	Plevachuk	Ukraine	01.06.2015	3
Other programmes				
Valeriy	Sidorov	Russian Federation	01.02.2012	3
Valeriy	Sidorov	Russian Federation	05.10.2015	2
David Rodriguez,	Barriuso	Spain	18.03.2013	6
Polyxeni	Vourna	Greece	01.10.2011	6
Ioannis	Kartosanakis	Greece	01.10.2011	6
Emilie	Lebrun	France	01.02.2012	3
Sophie Henriette	Herzog	Austria	01.08.2014	1

2.8.2.3. SAS stipends and SASPRO stipends

Programme SASPRO is mobility Programme of the Slovak Academy of Sciences dedicated for experienced scientists from abroad or Slovak citizens workig several years in research institutions abroad, who are interested in working at the organisations of the Slovak Academy of Sciences. Programme is partly supported by EU.

1. SASPRO 0098/01/01, Dr. Prajapati Pareshkumar Manharbhai, India
2. SASPRO 0055/01/01, Mgr. Daniel Reitzner, PhD., Slovakia
3. SASPRO 1250/02/01, Mgr. Daniel Nagaj, PhD., Slovakia
4. SASPRO 1239/02/01, Dr. Krisztán Palotás, Hungary

2.8.2.4. Internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

Stefan Schwarz fund is special fund established by Slovak Academy of Sciences for excellent absolvents of doctoral studies at Slovak and foreign universities.

Name	**Work contract**
	supported from - to
Chitu Livia Mgr. PhD.	1.1.2009 - 31.12.2012
Nagaj Daniel Mgr.PhD.	1.1.2009 - 31.12.2012
Liptaj Andrej Mgr.Ing.Dr.	1.5.2010 - 30.04.2014
Reitzner Daniel RNDr.PhD.	1.1.2011 - 31.12.2014
Turanský Robert RNDr.PhD.	1.1.2010 - 31.12.2013
Venhart Martin Ing.PhD.	1.1.2011 - 31.12.2014
Weis Martin Ing.PhD.	1.7.2009 - 31.07.2013
René Derian RNDr.PhD.	1.1.2012 - 31.12.2015
Rapčan Peter Mgr.,PhD.	1.5.2012 - 30.04.2016
Krčmár Roman RNDr.,PhD.	1.12.2014 - 30.04.2017
Strišovská Jana RNDr.PhD.	1.1.2014 - 31.12.2015
Vegso Karol Mgr.PhD.	1.1.2014 - 31.12.2017
Tokár Kamil RNDr.PhD.	1.6.2013 - 30.04.2017
Švec Peter Ing.PhD.	1.1.2013 - 31.12.2016
Rybár Tomáš Mgr.PhD.	1.10.2015 - 30.04.2019

2.8.3. Important research infrastructure *(max. 2 pages)*

1. **NANOLAB** - cluster of laboratories for nanotechnologies and nanostructures

Equipment: Langmuir-Blodgett troughs KSV (Nima), programmable spin coater, automatic film applicator (Zehntner), contact angle meter CAM 200, custom-designed dual ion beam sputtering device with in-situ ellipsometry and GISAXS monitoring (base pressure 2×10^{-8} mbar), confocal Raman microscope Alpha300R (WiTec), UV-Vis-NIR spectrophotometer (Shimadzu), optical 3D microscope with large working distance (Hitachi), imaging ellipsometer (Accurion), spectroscopic ellipsometers (Woolam, Sentech), fast tracking ellipsometer with 5 ms temporal resolution (own development), AFM devices Dimension Edge and Multimode 8 (BrukerNano), Bruker Nanostar device with Excillum high-flux liquid metal-jet anode microfocus X-ray source

Proposed use: preparation of large-area colloidal nanoparticle monolayer and multilayer arrays for plasmonic, photovoltaic and sensor applications, preparation of nanofilms within research of 2D materials, preparation and development of superhydrophobic coatings, in-situ GISAXS studies of nanoparticle self-assembly effects, development of high-quality protective and optical coatings and multilayer interference X-ray mirrors, ion beam-assisted deposition and ion beam polishing, small-angle and wide-angle X-ray scattering (SAXS, GISAXS, WAXS) studies of multiphase systems, in-situ GISAXS studies of metal growth on graphene and other non-conventional surfaces, morphology and optical characterization of coatings, 2D material nanofilms, nanoparticle self-assemblies, organic blends and metal clusters, studies of surface morphology and subsurface lattice damage within development of nanomachining for X-ray diffractive optics, 3D label-free selective detection and imaging of molecular complexes at subcellular level within development of advanced nanoplatform for cancer detection, preparation, testing and development of organic photovoltaic structures

2. **Laboratory of ultrafast laser photonics, common laboratory of IoP and ILL (Comenius university, STU)**

Main Equipment: Laser system COHERENT Legend Duo USX/USP with dual regime 25fs/100fs, 3,3mJ/4mJ, 3 KHz, 800 nm

Proposed use: Experiments in nonlinear optics, generation of THz pulses in gases and exotic media, time resolved absorption IR spectroscopy, determination of probabilities of multiphoton absorption and hyperpolarization, THz-TDS spectroscopy in time domain

3. **Laboratory of quantum measurements**

Main equipment: 3He/4He dilution refrigerator Leiden Cryogenics CF-1200 Maglev with 9 T magnetic field

Proposed use: Experiments with superconducting nonlinear nanostructures, quantum bits in microwave region and other experiment at temperatures below 20 mK and magnetic field up to 9T.

4. **Laboratory of metallic materials**

Equipment: Apparatuses for preparation of rapidly quenched and metastable metallic materials, thermal analysis equipment (diverse DSC, DTA, modulated DSC, dynamical mechanical analyzers), set of up-to-date X-ray diffractometers together with chambers for in-situ heating, cooling and environmental diffraction experiments, conventional and high-resolution transmission electron microscopes and full set of TEM specimen preparation devices, special thermomagnetomechanical processing devices and furnaces for fast annealing and for measurement of physical properties under diverse time-temperature regimes.

Proposed use: preparation of precursor alloys and rapidly quenched metallic systems, preliminary structure characterization, characterization of thermodynamic stability and transformation kinetics, processing of investigated alloy systems, property and structure tailoring.

5. **Electron microscope laboratory (common laboratory of IoP and IMMM)**

Equipment: Titan Themis 300 TEM/STEM microscope with X-FEG, 3rd generation probe corrector, four-quadrant windowless EDS capable of collecting 100 000 spectra/sec, ultrafast EELS (1000 spectra/sec), precession electron diffraction, four independent STEM signal detectors, one of them as four-quadrant detector capable of mapping of electromagnetic fields of specimen,

16M CMOS camera, specimen stage with piezoelements for active specimen drift compensation, set of diverse sample holders, plasma cleaner, sputter-coaters, image reconstruction HW and SW, ab-initio structure calculations. Information and resolution limits (TEM) 200pm at 300kV and 100pm at 300kV, respectively; STEM resolution 80pm at 200kV routinely achieved.
Proposed use: Analytical TEM/STEM microscopy of specimen with chemical resolution on atomic scales for determination of local atomic ordering in rapidly quenched complex metastable alloy systems, elemental mapping, comparison with structure models and ab-initio simulated and predicted structures and ordering; TEM/STEM tomography on nanometer scales, low-dose microscopy of beam sensitive samples, Lorenz imaging. Simultaneous fast acquisition of EDS and EELS spectra for complex structure characterization, differential phase contrast imaging in STEM mode using 4-quadrant detector for sub-micron mapping of electromagnetic fields of specimen and individual objects.

6. Laboratory of ion beams and nuclear reactions, Piešťany

Equipment: Electrostatic accelerator HVEE Tandetron 2 MV, CW electrostatic accelerator 200 kV, ORTEC high efficiency electrically cooled HPGe detectors, Cannberra Si X-ray detector, Si detectors for charged particle detection, thermal and fast neutron detectors, analog and XIA digital data acquisition systems, analytical RTG microscope Horiba XGT 7200.
Proposed use: studies of nuclear reactions and scattering as well as ion beam analysis of diverse samples, nuclear reactions of astrophysical interest, inelastic α particle scattering for nuclear reaction and nuclear structure studies, surface analysis (PIXE, PIGE, RBS, ERDA) of various samples of high tech as well as cultural heritage importance.

2.8.4. Description of how the results and suggestions of the previous assessment were taken into account

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

There were three suggestions in 2012 assessment:

1. Active participation in the process of systematic improvement of conditions for PhD studies at the institute

We support students by upgrading laboratory equipment, which enable improved experimental studies and quality of their PhD thesis and by improving their social benefits.

Training activities for diverse experimental, theoretical and computational techniques are actively offered as integral part of the accredited PhD programs; these are freely accessible and frequented by students perspectival aiming for PhD studies either at IP SAS or elsewhere.

Activities related to fostering social aspects of PhD studies are included in annual plan of the IP SAS trade union. Institute has a special programme financed by Institute's social fund to support diverse social nad team building activities of students.

2. Involvement in internationally funded projects

We are supporting applications for project proposals within H2020 program.
In the past, only single department was successful in application in FP7 programme.
At present two departments are successfull in two major H2020 programme projects. In additions, there are groups participating in several COST projects and in one M.ERA-Net project.

3. Enhancement of mutual cooperation with universities

We support cooperation with universities by creation of common laboratories, which enhance the research in specific research areas and deepens the contact between faculty and IoP staff and students. At present there are two common laboratories:

1. *Laboratory of ultrafast laser photonics*, common laboratory of Institute of Physics SAS, International Laser Center, Comenius University, Slovak Technical University. Laboratory is located at Faculty of Natural Sciences of CU.

2*. Laboratory of quantum measurements*, common laboratory of Institute of Physics SAS and Faculty of Mathematics, Physics and Informatics of the Comenius University. Laboratory is located at located at Institute of Physics SAS

In addition, numerous joint research projects with universities and other research partners from SAS and industry were realized or are being solved, where common laboratories with either fully open access or quasi-open access were established providing access to the top-quality up-to-date research equipment and know-how.

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

3. Research strategy and future development of the institute for the next five years (2016-2020) (Recommended 3 pages, max. 5 pages)

3.1. Present state of the art in both the national and the international contexts

3.2. Research strategy of the institute in the national and the international contexts, objectives and methods

1. Department of Theoretical Physics – head S. Dubnička

The Department of Theoretical Physics is currently focused to fundamental theoretical research of the structure of strong interacting elementary particles – mesons and baryons.

The department closely cooperates with the international centers of high energy physics as JINR, Dubna, and CERN, Switzerland. The staff works on common projects with the theoretical groups from the Institute of Physics at the Johannes Gutenberg University, Mainz, Germany; Kazakh National University, Almaty, Kazakhstan; Institute of Nuclear Physics, Cracow, Poland.

The interests for near-by future are to produce the theoretical predictions for the behavior of electric and magnetic form factors in the time-like region, followed by predictions of differential and total cross sections of hyperons, which are planned to be measured on new accelerators, e. g., BEPC-II which is currently hosting BESIII experiment.

The main goals can be formulated in the points:

- To focus on the analysis of the available experimental data by means of the extended Unitary and analytic model and on the prediction of electric and magnetic hyperon form factors separately, in conditions which have not yet been experimentally achieved.
- To propose new polarization methods of measurement of the electromagnetic and weak structure of hadrons, which would allow for a new perspective in the area of research?
- To evaluate observables (decay widths, angular distributions) for the decays of heavy mesons, focusing mainly those reactions which may be related to the discovery of new physics beyond the standard model and which are being measured on the present accelerators, e. g., B_s -> K_S+K*(892) decay at the LHCb experiment.

We expect to continue in the implementation of theoretical predictions in the framework of our elaborated Unitary and Analytic model of electromagnetic and weak structure of investigating particles, which has been successfully applied for the prediction of f0(500) scalar meson. Related issue is the evaluation of observables for the decay of heavy mesons in the framework of covariant quark model, which are the subject of interest for research at B-factory colliders. Recently with the cooperation with the Institute of Experimental Physics SAS, we elaborated a new theoretical concept that transfers contemporary string theory to the field of time series forecasting by the projections of the real exchange rate dynamics onto the string-like topology. The matter is extensively studied due to its attractive benefits and potential applications.

2. Research center for quantum information - head M. Ziman

The history of quantum technologies dates back to 80s of the last century when researchers started to realize that information encoded in quantum systems provide qualitatively novel features for information processing. It was realized that quantum superposition could help to enhance our computational abilities and transforms difficult problems into tractable ones. Phenomena of quantum uncertainty and entanglement provide conceptual framework for information security and privacy. While we are still quite far from building a multi-purpose quantum computer, the ideas of quantum cryptography are currently under focused effort of many research groups and they are reaching their testing phase.

The Research Center for Quantum Information is focused on research in quantum information sciences. It was established fifteen years ago and research-wise it is one of the leading research centers in Slovakia. It is mostly focused on theoretical aspects of quantum information, however, in last five years in collaboration with Comenius University an interesting superconducting infrastructure has been built and recently first experimental results in the area of quantum information has been achieved and reported.

The marketing success of Canadian company D-Wave selling already several "quantum-enabled" computing systems, serious investments of Google and Microsoft in this field, and plans of China to launch the satelites enabling quantum key distribution, stand behind the recent

increase of interest for quantum technologies within European research area. Researchers from IPSAS department RCQI were coordinating series of European coordination actions aiming to increase the impact of Europe in development of future quantum technologies and develop structures for sustainability of the leading role of European researchers in this field. As a result of these activities a strategic document Quantum Manifesto was prepared aiming to lauch a Flagship-scale Initiative in Quantum Technology. Quantum technologies are listed also among research priorities during the Slovak EU presidency, keeping the continuation of quantum initiative from the previous presidency.

The whole field of quantum technologies is developing rapidly. In the next five years we plan to continue in the development of current strengths of RCQI, i.e. development of algorithms for quantum simulations and verifications (tensor network methods, investigation of "simple" quantum complexity computational classes, efficient device-independent estimation algorithms), mathematical foundations of quantum theory (development of the theory of causal quantum networks, quantum memory effects) and designs of multi-partite quantum protocols for efficient information processing (quantum-based privacy protocols). Further, we plan projects addressing also novel research directions in the area of quantum technologies. Namely, quantum metrology (both theoretically and experimentally) aiming to evaluate the quality of quantum properties and phenomena, the emerging field of quantum machine learning representing medium-sized quantum applications, investigation of resource theory of quantum incompatibility, implementations of DMRG (tensor network) simulations for quantum chemistry and quantum gravity, and the development of theoretical framework of quantum complex networks. In the experiments we plan to realize few-qubit applications: implementation of few-qubit gates, state transfer in spin systems, simulation of spin systems at phase transitions, and preparation of Majorana states in superconducting architecture. We are actively participating in preparation of several COST actions along these research directions, thus, keeping the track of modern international trends in quantum technologies.

3. Department of Nuclear Physics – head M. Venhart

Department of Nuclear Physics is a typical example of a small-scale group. It is active mainly in the domain of nuclear reactions and nuclear structure studies. Department follows recommendations of the Nuclear Physics European Collaboration Committee (NUPECC), which issued a Long Range Plan in 2010, suggesting special support of smaller-scale facilities, since they have significant contribution to almost all domains of nuclear physics. Department will follow two objectives – development of newly established tandetron laboratory in Piešťany as well as participation in international collaborations at prestigious laboratories CERN ISOLDE, JYFL at University of Jyväskylä (Finland) and iThemba LABS in Faure (South Africa).

Experimental studies in Piestany will be concentrated on 2MV tandetron accelerator. In the first phase activities will be focused on research of nuclear reactions that are responsible for nucleosynthesis in stars, mainly on low energy (α,γ) reactions. We have proposal further upgrade of the machine with pulsing system that will allow producing sub-nanosecond pulsed beams. Since there is no dedicated inelastic neutron scattering facility active in Europe, we intend to develop as soon as the Tandetron laboratory is well established a neutron scattering facility in Piešťany. Nuclear structure studies performed using inelastic neutron scattering have the potential to play important role in understanding of the nuclear structure of collective configurations. This is very powerful, however rarely used technique that allows unique insight into the properties of collective excited states in stable isotopes.

Our experimental activities will include further development of an unique spectrometer TATRA, which is able of simultaneous high resolution studies of gamma rays and conversion electrons emitted by exotic radioactive nuclei. The system uses for transportation of radioactive nuclei an unique amorphous metallic tape produced at the Department of Metals, Institute of Physics. Samples are being created by a deposition of low-energy radioactive-ion beam. TATRA can be successfully used at any user facility producing such beams. Spectrometer has been successfully commissioned at the ISOLDE facility in August 2014 during the first run of the approved IS521 experiment, proposed by researchers from Department of Nuclear Physics. This run produced important and innovative data thanks to exceptional resolution. Based on this, Slovakia became an official member of the ISOLDE collaboration at CERN and the Institute of Physics is considered as a leading member in the field of conversion electrons spectroscopy at ISOLDE. . We plan to concentrate on studies of the shape coexistence phenomenon in neutron-

deficient isotopes and detailed studies of isotopes that are perspective for of Auger electrons cancer treatment.

We intend to run experiments using the TATRA at CERN ISOLDE, where we have approved beam time for our proposed experiments IS521 and IS581, and possibly also at the University of Jyväskylä. We will continue collaboration with group at iThemba LABS, which is interested in developing similar spectrometer.

Since there are several unique parameters of the TATRA system, it is possible to expect that within coming one or even two decades it will produce a large harvest of top quality data, with a major impact on understanding of the nuclear structure. This program has already successfully started and is supported by the ISOLDE collaboration and by Ministry of Education of the Slovak Republic.

4. Department of complex physical systems - head L. Šamaj

In the segment of supercomputer modeling, IP SAS will institutionalize the modeling as the third pillar to pure theory and pure experiment and make steps to stabilization of the situation in the supercomputing community. Simultaneously, discussion on procurement of a new supercomputer system replacing the current AUREL infrastructure should commence immediately. As for the future research projects, the group of computational materials science (CCMS) will in the named period focus primarily on the following research areas:

- study of electronic properties of 2D, graphene-like, materials
- study of metal â€“ group-IV-semiconductor nanocomposites for photonics
- computational support to SPM imaging and nanomanipulation (including nanotribology)

The Coulomb interaction is one of the four basic interactions in nature and plays a fundamental role in condensed matter and statistical mechanics. While the high-temperature properties of classical Coulomb fluids are well described by the linear Debye-Huckel or nonlinear Poisson-Boltzmann theories, the low-temperature description of thermodynamics is far from being understood. And this is just low temperatures where anomalous phenomena, like an attraction of the likely charged colloids in electrolyte, take place.

We proposed the zero-temperature Wigner crystal as a starting point for the strong-coupling expansion and developed a theory whose results are in agreement with Monte-Carlo simulations and experiments.

The scientific goal of high energy subgroup is to study quantum oscillation phenomena in matter medium, in particular, neutral meson oscillations in dense baryonic matter created in nucleus-nucleus collisions, and also in a low-density medium. The response of neutrino mass eigenstates to polarised leptonic matter will be studied, with the intention to search for the resonant oscillation behavior. The research will include non-perturbative exact solutions of simple 2-dimensional (Schwinger, Federbush, Rothe-Stamatescu) models; comparison of these operator solutions with the known or improved SL solutions; the computation of the mass spectra and LF wave functions of the 2-dimensional Yukawa and Thirring models, using the numerical diagonalization; the LF Hamiltonian analysis of non-abelian theories in various dimensions.

5. Department of Metal Physics - head P. Švec

Among the topics nowadays in focus on international and national scales are materials research and technologies with low CO2 footprint, reduction of energy-demanding technologies, reduction and replacement of strategic raw materials and elements and energy production and storage. New technologies are sought to prepare materials with enhanced performance or completely new classes of materials for use at elevated temperatures or harsh environments - construction elements, electrical and magnetic materials capable of efficient operation at high temperatures, reduction of mass to performance ratio, etc. On the other hand, especially processes related to production and storage of energy (e.g. in form of H2, O2) are sought which operate at lower temperatures and pressures, implying a need for development of new phenomena and materials capable of satisfying these requirements.

Department of Metal Physics has a firm and established standing worldwide in most of these areas due to its current achievements exploiting systematic research in preparation of modern complex metastable alloy systems, prediction of their feasibility and physical properties starting from ab-initio calculations and in tailoring of their properties by compositional and physical

processing methods during preparation and post-preparation treatment by knowledge-based processing algorithms.

DMP IP SAS plans to exploit synergically its potential in technological, experimental and theoretical research of complex metastable systems, combining atomic structure modeling with chemically resolved atomic microstructure studies and with investigations of their thermodynamic and kinetic stability and physical properties. The final aim is to produce new basic knowledge about the developed structures, phenomena and properties and potentially to assess applicability of the material systems developed. Specifically, the orientation is expected to be on special alloys (incl. high-entropy alloys) for extreme conditions, on new soft and hard magnetic materials eliminating the use of strategic elements and leading to enhanced properties (close-to-theoretical values of saturation magnetization, high energy products, energy conversion and storage, broadening of ranges of operational parameters – temperatures, pressures, etc.) and on phenomena in materials with specific surface or bulk structure enhancing diverse catalytic reactions – hydrogenation, dehydrogenation or oxidation of molecules.

Expected future research, including also future new classes of materials and phenomena which will be discovered in this period, relies on three basic methodological pillars:

- recent technologies already available and those planned to be implemented for preparation of investigated systems, recent high-resolution methods of structure investigation, recent methods in computational materials science using high-convergence algorithms of structure prediction and processing, recent experimental and processing instruments available.
- focused research activities related to new structures, phenomena and properties and the transfer of most recent solid state physics and materials science expertise (mainly in metals and alloys) towards university students and towards industrial partners into new technological processes and production of new materials.
- Focused science and technology driven activities in accord with the Horizon 2020 concept of the EU and the national RIS3 policies. Intense exploitation and application of recently acquired equipment and expertise obtained via Structural Funds of EU for fostering excellence of research and higher education in metal physics and related fields.

6. Department of Multilayers and Nanostructures - head E. Majková

With respect to previous results and expertize, approved national and international projects, and infrastructure, the Department will be active in the following research topics:

Advanced characterization of new emerging nanomaterials. Time-resolved studies based on elastic and inelastic scattering of electromagnetic radiation provide a unique tool to track in real time formation, modification and functionalization of various types of nanoobjects, nanoassemblies, nanocomposites. Adopting relevant theoretical models, a detailed insight into the mechanisms governing the properties of interest can be obtained which is a necessary prerequisite for tailoring functionalities of the final product. The time-resolved Raman confocal micro-spectroscopy and the X-ray coherent and incoherent (diffuse) scattering with fast detection in ms range and covering the length scales from nm to μm range will provide a complex picture of the temporal and spatial landscape of the relevant processes.

Sustainable energy. The organic/inorganic perovskite-based solar cell structures exhibit a very promising power conversion efficiency (PCE) exceeding 20% in the best cases. The long-term stability, durability, resistance against environmental factors and reduction of production costs are the main challenges to bring these solar cells to the application stage. Here, optimization of the solar cell architecture to maximize PCE and to stabilize solar cell parameters along with a convenient encapsulation are the problems to be solved while incorporation of conductive polymers combined with various carbon nanomaterials such as nanotubes and nanosheets provides a viable option to reduce substantially production costs.

Functionalized 2D materials for sensing, detection and bioapplications. 2D materials exhibit unique properties with new functionalities that may be utilized for breaking present limits in sensing and detection in various fields. Graphene-based gas sensors with enhanced sensitivity up to ppb range are the ones of present challenges with implications for health care and civil security. Recently, the new widely interdiscipliniary research on development of innovative functionalized nanoplattforms based on graphene oxide, MoS2 and other 2D nansheets for detection and treatment of cancer cells started in Slovakia. Here the research teams active in biomedical/cancer

research collaborate with our Department and other research group working in nanoscience. Our challenge for the future: *window to bioworld*. By application of graphene membrane it will be possible to separate the biologically friendly environment neccesary for cell and vacuum/air environment suitable for X-ray and/or light application. This way, the processes between cell and proteins and other type of molecules, could be studied in situ in real conditions.

New elements of high-throughput X-ray optics are needed urgently to fully utilize potential of new types of high-flux laboratory X-ray microfocus sources. To enhance resolution in the reciprocal or direct space while keeping high flux are the main challenges for advanced nanostructure diagnostics. Combination of the rreflective interference multilayer optics and diffractive crystal optics provides a way towards a new generation of high-throughput X-ray optics. To realize this idea, modelling based on the dynamical theory of X-ray scattering and the ray tracing approach is needed to optimize the input and output beam parameters and to tailor the optics design for particular applications. The new reflective-diffractive X-ray optics will allow to perform laboratory X-ray scattering experiments of unprecedent quality that are confined to a limited number of European synchrotron sources at present.

Challenges in applied research: High-quality active surfaces for the next generation of the crystal X-ray optics. The single-point diamond technology (SPDT) is a technique of surface treatment by deterministic nanomachining in ductile regime known from the preparation of optical elements for infrared lasers (wavelength several 100 nm). It provides both a very low local roughness and high planarity which is attractive also for crystal X-ray optics where traditional chemical stochastic surface treatment results in poor planarity. Moreover, the possibility to prepare high-quality free-form optical surfaces is another bonus. However, the SPDT implementation to X-ray optics (wavelength below 1 nm) is a great challenge due to inherently much stricter requirements put on local roughness comparing with lasers and necessity to minimize subsurface damage of the crystal lattice. If successful, it will allow to break present technological barriers and to realize new elements of X-ray optics that exist only in the form of plans and sketches nowadays.
(collaboration with strategic industrial Integra TDS Ltd., Piešťany)

Project proposals submited to 7RP or H2020	2012	2013	2014	2015
Institute as coordinator	3	8	1	2
Institute as participant	2	3	6	2

4. Other information relevant for the assessment

Annex No. 1 Selected topics in popularization of science

A/ Books, chapters

LUBY, Š.: Insights into the nanoworld / Pohľady do nanosveta, Centrum vedeckotechnických informácií SR, vyd. Matice slovenskej, Martin 2015, 118 s. ISBN 978-80-8115-207-8.
Populárna kniha pre stredné školy distribuovaná v 3500 výtlačkoch bezplatne na školy SR

LUBY, S., Hajko, V., ml., editori, V. Hajko: The head of the Slovak Academy of Sciences /V. Hajko: Na čele Slovenskej akadémie vied (1974 – 1989), VEDA, vyd. SAV, Bratislava 2015, 103 s, ISBN 978-80-224-1455-5.
Pohľad do histórie SAV

LUBY, S,. Nanosensors detect explosives, chapter in Horizons of new technologies Obzory nových technológií, kap. Nanosenzory odhaľujú výbušniny, s.69 – 70, pre CVTI SR vydalo vyd. Matice slovenskej, Martin 2015, 119 s., ISBN 978-80-8115-213-9.
Podobná koncepcia ako 21

B. Popular Lectures

2012

TUNYI, I., LUBY, Š, The peaceful use of nuclear explosions/Mierové využitie nukleárnych výbuchov, Fyzika a etika VI, Zborník, ed. I. Miháliková, UKF Nitra, Nitra 2012, s. 63 – 70. ISBN 978-80-558-0085-1.

LUBY, Š., Perspectives and conditions of using solar energy in Slovakia/Perspektívy a predpoklady využitia slnečnej energie vo svete a na Slovensku, Katolícka univ. Ružomberok, apríl 2012.

LUBY, Š., Solar cells and photovoltaic energy future/Slnečné články a budúcnosť fotovoltaiky, Trenčianska univerzita A. Dubčeka, 26. 6. 2012.

LUBY, Š., Perspectives and conditions of using solar energy in Slovakia/Perspektívy a predpoklady využitia slnečnej energie na Slovensku, XXXV. Vanovičove dni, 29. – 31. 8. 2012, Martin.

2013

LUBY, Š., What physics has to do with security /Čo má fyzika spoločné s bezpečnosťou, CVTI SR, Vedecká kaviareň, réžia Z. Hajdu, 31. 1. 2013.

LUBY, Š., The nanoelectronics and informatics/O nanoelektronike a informatike, Univerzita III. veku, STU, 1. 2. 2013.

LUBY, Š., Nanotechnology in medicine, some benefits and threats, Conf. on Emerging Ethical Issues in S&T, UNESCO/COMEST, Hotel Falkensteiner, Bratislava, 30. – 31. 5. 2013. **invited paper.**

LUBY, Š., History of nanotechnology /Dejiny nanotechnológie, Quark, november 2013, s. 18 – 19.

LUBY, Š., What is the future of nanotechnology?/Aká je budúcnosť nanotechnológie? Quark, december 2013, s. 22.

2014

ČERVENANSKÝ P., LUBY, Š.: RR Encyclopedia Beliana/ Encyklopédie Beliana, Encyklopedický ústav SAV, marec 2014.

S. Luby, The threat of terrorism and Slovakia /Hrozby terorizmu a Slovensko, SCOPE, I/2014, s. 5 – 8.

Š. Luby, Giant consequences of dwarf technology/ Obrie dôsledky trpasličej technológie, Petržalská superškola, Dom kultúry Zrkadlový háj, 17. 12. 2014.

2015

LUBY, Š., Research of safe societies - a challenge for SAS/ Výskum bezpečných spoločností – výzva pre SAV, Správy SAV, č. 2/2015, s. 22.

LUBY, Š., Safety/Bezpečnosť, Konf. Spoločné východiská výskumu v kontexte aktuálnych spoločenských výziev, PgÚ SAV, Smolenice, 18. 5. 2015

LUBY, Š., LUBYOVÁ, M., Nanosciences and nanoethics Nanoveda a nanoetika, Quark jún 2015, s. 44 – 45.

LUBY, Š., Giant consequences of dwarf technology/Obrie dôsledky trpasličej technológie, Superškola v Starom meste, ZŠ Jelenia 16, 25. 9. 2015.