Questionnaire
Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Institute of Experimental Physics Slovak Academy of Sciences (IEP SAS)
(Ústav experimentálnej fyziky Slovenskej akadémie vied, v. v. i. (ÚEF SAV, v. v. i.))
Watsonova 47
040 01 Košice
Slovak Republic

1.2. URL of the institute website

http://uef.saske.sk/

1.3. Executive body of the institute and its members

Directoriat	Name	Year of birth	Years in the position, from - to
Director	Zuzana Gažová	1961	2019 -
	Peter Kopčanský	1955	2015 - 2019
Deputy director	Alena Juríková	1966	2011 -
Scientific secretary	Slavomír Gabáni	1974	2019 -
	Katarína Šipošová	1982	2017 - 2019
	Pavol Szabó	1968	2011 - 2016

1.4. Head of the Scientific Board

Jozef Kačmarčík (1972), 2021 -
Pavol Bobík (1974), 2017 - 2021
Pavol Farkašovský (1962), 2015 - 2017

1.4.1 Members of the International Advisory Board

Prof. RNDr. Rupert Leitner, DrSc., Institute of Particle and Nuclear Physics, Faculty of Mathematics and Physics Charles University, V Holešovičkách 2, 180 00 Prague, CR
Prof. MUDr. Pavel Martásek, DrSc., Biotechnology and Biomedicine Center of the Academy of Sciences and Charles University, Průmyslová 595, 252 50 Vestec, CR
Prof. Dr. hab. inž. Marek Przybylski, AGH University of Science and Technology, Academic Centre for Materials and Nanotechnology, A. Mickiewicza Av. 30, 30-059 Kraków, Poland

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
107.99	76.62	110.21	71.80	104.90	67.22	103.33	68.12	103.67	66.85	103.69	66.36	**105.63**	**69.50**

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

1.6. Basic information on the funding of the institute

1.6.1. Institutional salary budget, other salary budget[1], non-salary budget[2]

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget *[millions of EUR]*	1.627	1.658	1.760	2.067	2.339	2.292	**1.957**
Other salary budget *[millions of EUR]*	0.100	0.185	0.180	0.281	0.323	0.274	**0.224**
Total salary budget *[millions of EUR]*	1.728	1.844	1.940	2.348	2.662	2.566	**2.181**
Non-salary budget *[millions of EUR]*	0.780	0.847	0.878	1.044	1.025	0.848	**0.904**

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

The areas of interest at the Institute of Experimental Physics include basic research in condensed matter physics, sub-nuclear physics, space physics, biophysics as well as in selected areas of chemical, biological sciences, and nanotechnolgies.

In the field of condensed matter physics, studies on magnetic, thermal, transport, optical, and mechanical properties of condensed matter: metallic magnetic materials (since 1972), superconductors (since 1978), magnetic fluids (since 1987), quantum fluids (1989), nano structures (since 1990), molecule-based magnets (since 1998), transition metal oxides with perovskite crystal structure (since 2008), etc., have been carried out at the IEP SAS with the premise to elucidate and understand the magnetic properties from atomic to microscopic levels and properties of the matter at very low temperatures.

The interests of the biophysical research groups include study of the structure, conformation and dynamics of biological macromolecules, their intra- and inter molecular interactions and other physical forces leading to self assemblies, and intermolecular interactions of biological macromolecules, their supramolecular structures and models (since 1984).

In the field of space physics, IEP SAS scientists perform studies on the energy distribution of space particles and space radiation using measurements carried out by space satellites as well as on land observatories (especially at Lomnicky stit in High Tatras Mountains, Slovakia) before the beginning of IEP SAS (since 1958).

[1] Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.
[2] Includes Goods and Services and PhD fellowships

The subnuclear and particle physics research in IEP SAS is carried out via active participation in major experimental programmes at the Large Hadron Collider of the world's leading particle physics laboratory CERN, Geneva, Switzerland (since 1991).

The research carried out by the members of the theoretical physics department is focused mainly on non-linear stochastic dynamics in addition to elucidating answers to questions raised by other active research areas within the institute (as mentioned above) by employing theoretical physics.

The institute has established and maintains production, storage and distribution of liquid helium (since 1969); this facility does not only support the needs of IEP SAS and other institutes within the Slovak Academy of Sciences, but also supply national commercial customers.

The institute provides IT support, expertise and securities for network/Internet services for all SAS institutes in Košice (CITKE, since 2008).

The research carried out by the scientific community of the Institute is in accordance with all ethical recommendations and legal laws. Scientific results are publically disclosed at national and international level in form of abstract/poster submissions at conferences and as original research articles published in peer reviewed periodic and non-periodic journals. Intellectual properties that can lead to successful patent applications are non-disclosed and submitted to Slovak and International Patent Offices.

The institute sponsors doctoral studies in cooperation with the Faculty of Science, P.J. Safarik University (Theoretical physics, Condensed matter physics, Nuclear and subnuclear physics (all since 2004), Biophysics (since 2016), Advanced materials (since 2019)), with the Faculty of Electrical Engineering and Informatics, Technical University of Kosice (Physical engineering of advanced materials (since 2016)) and with the Faculty of Materials, Metallurgy and Recycling, Technical University of Kosice (Materials (since 2009)).

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

The research and development activities of the IEP SAS were focused on 3 main areas:
- Condensed Matter Physics
- Biophysics and Chemical Physics
- Space and Particle Physics

The research was realized in 18 research groups organized within 10 departments.

CONDENSED MATTER PHYSICS

Centre of Low Temperature Physics (CLTP)

Research groups:

- **Superconductivity**
- **Quantum fluids**
- **Materials under extreme conditions**

For a long time, CLTP has been member of the most prestigious club of the low temperature laboratories – the European Microkelvin Platform (EMP), which is an advanced distributed European research infrastructure in the field of ultra-low temperatures and ultra-sensitive measurement techniques with a specific focus on quantum technologies and quantum materials. In 2018, EMP consortium was granted a 4 - year EU-funded eponymous project H2020 (https://cordis.europa.eu/project/id/824109), where CLTP belongs to 8 core founding partners providing open access to its infrastructure, developing new technologies and

performing joint research activities. CLTP has also been a founding member of the Slovak National Research Platform on Quantum Technologies (http://qute.sk). Within these and other projects, new cutting-edge experimental techniques were developed in the Centre (see Chapt. 2.8.3). Since the establishment of low temperature physics in Kosice more than 50 years ago, CLTP has always been concentrated on forefront research at extreme conditions (low and ultra low temperatures, high magnetic fields, high pressures and low dimensions) and transfer of the knowledge from fundamental research to application. During the evaluation period we carried on research of quantum fluids, superconductors, heavy fermion systems, etc. Below we provide some of the most important results the CLTP has achieved.
The research of superconductivity has been focused on the challenging problems of high temperature superconductivity in cuprates, the role of disorder close to the superconductor-insulator transition (SIT), influence of competing orders on superconductivity and two-dimensional/topological superconductivity. As examples of our results, we suggest: the thermodynamic signatures of quantum criticality in cuprate superconductors, which has been experimentally detected [B. Michon et al., Nature 567 (2019) 218], **[1]**; fermionic scenario for the SIT in ultrathin MoC films, which has been for the first time evidenced by STM measurements [P. Szabó et al., Physical Review B 93 (2016) 014505] and further studied in applied magnetic field **[2]**; the unique coexistence of magnetism and superconductivity, which has been observed in boron doped diamonds [G. Zhang et al., ACS Nano 11 (2017) 5358], where Yu-Shiba-Rusinov bands have been evidenced **[3]**; the influence of charge density wave on the energy gap in Cu_xTiSe_2 **[4]** and the influence of high pressure on topological superconductor β-Bi_2Pd **[5]**. Extreme in-plane upper critical magnetic fields by order higher than the Pauli limit have been found in the bulk misfit layer compounds of $(LaSe)_{1.14}(NbSe_2)_{m=1,2}$ [P. Samuely et al., Physical Review B 104 (2021) 224507]. The latter case brought the first evidence of Ising superconductivity in a bulk material.
Keeping in mind the interdisciplinary aspect of the research, the superfluid phases of quantum fluid helium-3 have been used as model tool for exploration and investigation of various physical phenomena, in particular those related to cosmology and high energy physics. We performed an experiment in the limit of absolute zero temperature (600 microK) studying the spin wave analogue of black/white-hole horizons using magnonic superfluidity in superfluid ^{3}He-B. As an experimental tool simulating the properties of the black/white-hole horizons, we used the spin-precession waves propagating on the background of spin super-currents between two Bose-Einstein condensates of magnons in the form of homogeneously precessing domains. We provided experimental evidence of the black/white holes formation for spin precession waves in this system, together with the observation of an amplification effect. For details see **[6]**. Another two examples we would like to present are: (i) experimental observation of a new phenomenon that we have interpreted as an NMR-like effect generated by mechanical motion on an anisotropic magnetic moment of the surface Andreev bound states in topological superfluid ^{3}He-B in the zero-temperature limit [M. Človečko et al., Physical Review B 99 (2019) 104518], and (ii) potential application of the quartz tuning forks as low temperature thermometers below 1K, but in high magnetic fields **[7]** (for more details see Chapt. 2.1.8).
The research of strongly correlated electron materials under extreme conditions is focused mainly on magnetism and superconductivity in rare earth borides **[8]**, especially on: (i) unconventional insulator SmB_6 which has recently been considered to be a topological Kondo Insulator, as well as on (ii) geometrically frustrated metallic quantum magnet TmB_4. Investigations of the electron band structure of SmB_6 by direct methods of ARPES **[9]** and STM [H. Herrmann et al., Advanced Materials (2020) 1906725] down to milikelvins have confirmed the trivial origin of surface states. Isosbestic points in doped SmB_6 as features of universality and property tuning were observed for the first time **[10]**. Also, for the first time the rotating magnetocaloric effect (R-MCE) has been investigatied in TmB_4 **[11]**. This study presents a new type of magnetic refrigerant with a rather large R-MCE for low temperature magnetic refrigeration, which can also be an effective tool for investigating the microscopic magnetic properties of frustrated systems. Moreover, tuning of the magnetocaloric effect (MCE) in the Lu-doped TmB_4 was studied experimentally as well as theoretically in collaboration with the Theoretical department. This study shows that the efficiency of the MCE can be adjusted by dilution with nonmagnetic Lu^{3+} ions [M. Orendáč et al., Physical

Review B 102 (2021) 174422]. Developed theoretical model can be used to design new magnetocaloric materials.

Department of Materials Physics

Bulk REBCO superconductors represent a new category of superconducting materials with unique properties suitable for applications. Grown single-grain bulk superconductors (BSS) are studied by methods of thermal analysis, X-ray analysis, scanning electron and optical microscopy, and magnetization measurements. The most valuable results were obtained in GdBCO-Ag-Ce system. We investigated the effect of cerium dioxide addition on the structure and superconducting properties. We were first to show that the added cerium dioxide suppresses barium/gadolinium substitution in the crystal lattice of the superconducting Gd (Ba1-yGdy) 2Cu3Ox compound, thereby increasing the critical superconducting transition temperature and regulating the concentration of nanoscale pinning centres of magnetic flux lines. The addition of cerium dioxide can thus increase the homogeneity of the superconducting transition temperature within the BSS and optimize the critical current density at higher magnetic fields **[12]**. The found effect of cerium dioxide addition on the superconducting properties of GdBCO-Ag-Ce BSS is a subject of patent application. For YBCO-Ce system we have shown that even low addition concentrations of nanocrystalline BaCeO3 ensure submicron particle size of pinning centres in the form of Y211 nonsuperconducting particles, leading to a significant increase of trapped magnetic field values **[13]**. We studied commercial YBCO BSS manufactured by CAN Superconductors a.s. to assess the effect of local structure on transition temperature and critical current density over a wide temperature range from 4.2 K to 77 K. We have shown that critical current density is affected mainly by the concentration and the size of Y2BaCuO5 particles and by the structure of the subgrains **[14]**. We characterized the microstructure of YBCO BSS prepared in Shanghai SJTU from modified precursors (mixtures of Y203 and Ba-Cu-O) and showed that layered application of precursors with the highest concentration of Y2O3 at the beginning of crystallization leads to the most favorable distribution of fine 211 particles, causing higher trapped magnetics field **[15]**. We anticipate the use of the acquired knowledge in the framework of cooperation with the manufacturer of bulk singlegrain superconductors CAN Superconductors a.s. In addition to research at REBCO BSS, part of our capacity has been dedicated to investigation of magnetic materials for sensors. In cooperation with UPJŠ Košice and small company RV Marnetics, Heusler alloys in the form of rapidly solidified ribbons and glass-coated micro-wires were studied. Our main results concern the solidification and microstructure of these materials **[16], [17]**. During the period under review, DMP members participated in international cooperation with SIT Tokyo (Japan), University of Cambridge (UK), University of Caen (France), SJTU Shanghai.

Department of Metal Physics

Metallic glasses are materials in a metastable state with a unique combination of physical properties and growing application potential. The research was focused on the study of structural stability, deformation processes and failure of metallic glasses.

Using the calorimetric and dilatometric data specially derived in a special experiment on three Zr-based bulk glasses, the values of the parameter $\beta = \partial\Delta H_{\mu}/\partial\Delta v_f$ (ΔH_{μ} is the molar enthalpy change and Δv_f is the relative volume change) characterizing the enthalpy release due to the densification upon structural relaxation below the glass transition are determined. The experimentally determined parameter was compared with the value theoretically estimated assuming *i)* vacancy-like (free volume) and *ii)* interstitialcy-like relaxation mechanism. It was found that experimental β is 3 to 4 times bigger compared to this parameter estimated under the former assumption but agrees with the calculation performed under the latter hypothesis. Therefore, it is argued that the heat release upon structural relaxation-induced densification is mostly related with the annealing of interstitialcy-like kinetic units (“defects”) **[18]**.

Amorphous metallic glass CuTiZrNiSi was investigated by load-control nanoindentation experiments using the cube corner indenter tip over a wide range of loading rates. The indentation hardness was calculated using different methods either from the loading curves or indent area. It was observed that the instantaneous plastic deformation decreases with increasing loading rate according to a power law. For all loading rates the minimal value of

instantaneous displacement is 18 nm. At high loading rate the instantaneous deformation is suppressed by continuous plastic deformation and no well-developed pop-ins are observed. The morphology of shear bands in the pile-up area of indents showed no correlation with the pop-in event population of the nanoindentation curves and the loading rate. The plate-like morphology is formed by both stepwise and continuous deformation **[19]**.

Department of Magnetism

Research groups:

- **Magnetic fluids**
- **Technological laboratory**

Magnetic fluids as one of the pioneers of modern nanotechnology are still attractive for basic as well as applied research. The combination of fluidity and magnetism in a magnetic fluid allows the flow properties to be controlled by an external magnetic field thus changing the properties required in various applications.

Our research into ferrofluids for electrical engineering applications has revealed remarkable electrical polarizability of ferrofluids based on transformer oil, thus opening a question of potential application of the ferrofluid in the energy storage area. Moreover, the polarizability is controllable by an external magnetic field **[20]**. In another study we found that dielectric permittivity of a ferrofluid based on transformer oil may exhibit seemingly negative values at low electric field frequencies **[21]**. The permittivity sign switching is induced by an external static electric field superimposed on the alternating electric field. This behavior reflects the transition of the ferrofluid from a capacitive to an inductive nature. The transition is facilitated by the nanoparticle assembly and percolation as a response to the polarizing static electric field. It is proposed that such permittivity sign switching may open novel applications of ferrofluids, e.g. in switching and sensors. The research and applications of ferrofluids may also be broaden owing to our recent finding of the electro-magnetic coupling in the nanofluids. We have demonstrated that magnetic susceptibility of ferrofluids can be controlled by electric forces, analogously to the more famous controllability of ferrofluids flow and dielectric properties by magnetic forces **[22]**.

Magnetic fluids based on liquid crystals (LCs) constitute a fascinating class of soft condensed matter characterized by the combination of fluidity and long-range order. Today this full breadth of the liquid crystalline state of matter is becoming increasingly recognized and numerous new and exciting lines of research are being opened up. Hybridization of magnetic nanoparticles (MNPs) and LCs can effectively modify the electro- and magneto-optic responses and other physical characteristics of the LCs. However, the MNP-matrix interactions in these systems are highly complex and depend on various parameters related to the size, shape, topology, surface structure and magnetic properties of the MNPs on one side and the structure and dimensions of the LC mesogens on the other. Suitable combination of MNPs and LC opens the doors towards application possibilities such as low magnetic field sensors or basic logical elements for information storage technologies **[23]**. Another interesting effect was observed in LC doped with aerosol and magnetic nanoparticles. The prepared colloidal systems exhibited dielectric hysteresis in nematic phase at ambient temperature. Our studies revealed that temperature erased the observed effect as well as the fact that the different oriented magnetic field changed the magnitude of memory effect **[24]**. The potential application of these composites leads to a fabrication of non-volatile and low power electro-optical memory devices suitable for information storage applications. We also demonstrated that the anchoring of a nematic liquid crystal on a solid substrate together with the anchoring of the liquid crystal on a nanoparticle surface induces orientational self-assembly of anisometric nanoparticles in liquid crystal droplets **[25]**. The observed phenomenon opens a novel route for fabrication of thin colloidal films with tailored properties.

Currently, the intensively studied particles in the field of bioapplications are iron-based. In case of synthetically prepared particles it is necessary to modify their surface by coating with a suitable surfactant in order to prevent the formation of aggregates and ensure biocompatibility. From this point of view the particles of bio-origin are interesting where no further surface modification is needed. Namely, these are magnetosomes, ferritin/magnetoferritin and magnetite nanoparticles in agar tissue-mimicking phantoms. Ferritin a globular metalloprotein represent a biological storage protein of iron in living

organisms (For more details see section 2.1.8). Analysis of the magnetosomes' magnetic susceptibility development was published in **[26]**. Measurement of the real and imaginary part of the magnetosome chains' magnetic susceptibility showed a different nature of the frequency dependence. The main part of the work is the introduction of the so-called "Flexible rod model", which describes the asymptotic behavior of complex magnetic susceptibility at high frequencies. Experimental measurements of the frequency dependence of magnetic susceptibility were correlated with the theoretical model for flexible magnetic rod-shaped objects.

Another interesting material is magnetically modified (nano)textile which could be employed in a wide range of (bio)applications, in particular: nanozymes, enzyme-mimicking materials or other catalysts having peroxidase-like activity immobilized on a suitable textile carrier (preferably magnetically responsive one) can be used as alternatives to the immobilized natural enzyme peroxidase for selected applications in environmental technologies, e.g. degradation (decolorization) of organic dyes, polymerization of phenol and its derivatives, degradation of endocrine disruptors or polychlorinated biphenyls etc. **[27]**.

The interesting phenomena for basic research of transition metal oxides with perovskite crystal structure are e.g. multiferroicity and magnetoelectricity or complex magnetic structures **[28], [29], [30]**. From the application point of view, these systems can be used as cathodes for solid oxide fuel cells, gas sensors, materials for magnetic cooling, or hyperthermia. Tuning of chemical composition enhanced the application potential of transition metal oxides and brought these materials close to everyday use. Our study revealed that $RMn_{1-x}Fe_xO_3$ system with Nd, Pr and Tb forms substitutional solid solution in whole concentration range, cooperative Jahn-Teller distortions (CJTDs) and orbital ordering are suppressed by Fe substitution. Oxygen content affects CJTDs and orbital ordering. We determined structural and magnetic phase diagram of this system including description of magnetic structures and spin reorientation processes. Low concentration substitution of Mn with Fe in $RMn_{1-x}Fe_xO_3$ for R = Tb and Dy indicates enhanced sensitivity of multiferroic properties on magnetic field but results in suppression of multiferroic phase. We succeeded in preparation of magnetic nano particles based on hole doped $La_{1-x}Ag_xMnO_3$ with pretty high magnetocaloric effect at room temperature which are intended for hyperthermia application.

Department of Applied Magnetism and Nanomaterials

Soft magnetic nanocrystalline materials exhibiting giant magnetoimpedance effect (GMI) were subject of our interest due to their potential applications in magnetic sensors. We have studied the magnetoimpedance response and magnetic properties in field-annealed nanocrystalline FINEMET-type alloys prepared in the form of single-layer and bilayer ribbons. The magnetoimpedance strongly depends on the correlation between thickness of ribbon and skin penetration depth. Our results revealed that the thicker bilayer ribbons show a lower characteristic frequency at which magnetoimpedance change achieves the maximum. The bilayers are more suitable for applications at low frequencies (between 2 and 5 MHz) and single-layers are more appropriate for utilization at intermediate frequencies (around 10 MHz) **[31]**.

La-Fe-Co-Si based compounds belong to a promising group of magnetocaloric materials, capable of operation in the vicinity of room temperature. Our studies were devoted to tailoring of magnetic and magnetocaloric properties by partial substitution of La atoms for Pr or Ho atoms. Detailed analysis of phase transition using Arrott plots, the Landau theory for order parameter and the construction of a universal scaling curve revealed that a partial replacement of La with Ho or Pr results in a weakening of the metamagnetic transition, which is reflected by decrease of magnetic entropy change in these compounds **[32]**.

Part of our research interest was devoted to development of novel permanent magnets free of critical elements. Among others, the Mn(Al,Bi)-based materials appear to be promising rare-earth free permanent magnet systems. We have focused our attention on Mn-Al and Mn-Bi based alloys produced by melt-spinning method. Magnetic behaviour of such alloys depends strongly on the presence of specific hard magnetic phases: τ- MnAl in Mn-Al, and LT α-MnBi phase in Mn-Bi. Samples prepared in the form of thin ribbons were annealed using diverse regimes to obtain the required phase composition and structure. The optimum annealing conditions has led to marked increase of the maximum energy product (BH)max, which is a commonly used figure of merit for permanent magnet materials **[33]**.

Heterogeneous nanocomposite systems composed of ferromagnetic Fe and ferrimagnetic Fe3O4 phases were synthesized by combination of high energy ball milling and controlled oxidation. The morphology of the nanocomposites revealed a lamella-like structure with thickness of about 30 nm. Following the structural and morphological characterizations, we have investigated the effects of varying Fe3O4 phase fraction on the magnetic properties of the Fe/Fe3O4 lamellae. Interestingly, our lamellae exhibited a very clear and sharp Verwey transition near 120 K. This phenomenon related to sudden crystal lattice change from a monoclinic structure to the cubic inverse spinel structure is usually suppressed or absent in Fe3O4 nanoparticles due to imperfections in their crystalline/stoichiometric characteristic **[34]**.

Department of Theoretical Physics

Within the condensed matter physics the following most important results have been reached:

Examining effects of various factors, like the *f*-electron hopping, the local and nonlocal hybridization, as well as the increasing dimension of the system on a formation and condensation of excitonic bound states in the strongly correlated electron systems we have found that (i) the negative values of the *f*-electron hopping integrals t_f support the formation of zero-momentum condensate, while the positive values of t_f have the fully opposite effect; (ii) the opposite effects on the formation of condensate exhibit also the local and nonlocal hybridization. The first one strongly supports the formation of condensate, while the second one destroys it completely; (iii) the zero-momentum condensate remains robust with increasing dimension of the system **[35]**.

The existence of an intermediate spin-liquid-like phase was proven in the frustrated antiferromagnetic spin systems on the body-centered cubic lattice with the presence of the nearest-neighbor and the next-nearest-neighbor interactions, which separated the antiferromagnetic Néel and collinear phases at low temperatures **[36]**.

Based on the concept of negativity, it was observed for a mixed spin-(1/2 S) quantum Heisenberg dimer (S>1/2) that the increasing spin difference can enhance the quantum as well as the thermal entanglement, however the easy-plane single-ion anisotropy has to be present. In a quantum dimer with a higher spin difference the variation of magnetic field leads to the interesting oscillating behavior of entanglement as a consequence of multiple magnetic transitions **[37]**.

Recent studies on the structure of graphene have used cosmological methods by making analogies with space-time structure. Specifically, we aimed to make contribution regarding the mathematical structure of graphene, through the use of special-manifolds, performing cosmological studies and applying the field equations of Relativity and String theory to the structure of graphene. Finally, the project describes some exotic graphene objects as the Chern-Simons wormhole model **[38]**.

BIOPHYSICS and CHEMICAL PHYSICS

Department of Biophysics

Research groups:

- **Amyloid structures of proteins**
- **From biomacromolecules to supramolecular complexes: experimental and theoretical studies of the structure, stability and reactivity**
- **Biomedical image analysis**

Department of Magnetism

Research group:

- **Magnetic bionanomaterials**

One of the topics of interest at the Department of Biophysics deals with understanding the biophysical principles underlying the self-assembly of poly/peptides into amyloid oligomeric/fibrillar aggregates, which are hallmarks of more than 50 diseases known as amyloidosis. In terms of incidence, amyloid-related diseases are among the most important pathologies in the developed world as they are strongly associated with aging, such as Alzheimer´s disease (AD) and Parkinson´s disease, or with lifestyle, for example, type II diabetes.

Up to this day, the precise mechanisms of protein amyloid formation at the molecular/atomic level are still unknown. Namely, the knowledge of early events during aggregation is still obscure. Through our research, we contributed to understanding the relationship between the native protein conformation of three insulin variants with very high similarity in amino acid sequence (~ 98 %) and the formation of non-native protein conformers with a high propensity to form amyloids. The study points out that the kinetics of amyloid formation and morphology of formed amyloid aggregates are not identical, probably due to competing fibrillation pathways. The important role plays the two carboxyl-terminal residues of the insulin B-chain together with the salts bridge and hydrogen bonds affecting the stability of protein monomers. These data highlight the role of amino acid residue-specific contacts of protein in aggregation [B.N. Ratha et al., Journal of Physical Chemistry B 124 (2020) 1125].
The amyloid-related diseases are currently incurable. Nowadays, it is generally accepted that reducing the amount of amyloid aggregates represents possible strategies for treating of amyloidosis and/or increasing the application of the poly/peptides in pharmaceutical and biotechnological applications. We have identified the effective amyloid inhibitors and analysed the relationship between inhibitor structure and its inhibitory effectivity using several approaches.
Firstly, we have tackled the hypothesis that the rational design of anti-amyloid agents based on short peptides derived from the amyloidogenic sequence of the protein (region of a protein structure critical for amyloid fibril formation) might offer a promising prospect for designing an effective amyloid inhibitor. Three short lysozyme-derived peptides with one- or two-point mutations changing their charge and hydrophobicity showed the capability to interfere with lysozyme fibril formation. The short peptide with higher positive charges was the most effective inhibitor by stabilizing the native lysozyme structure **[39]**. In case of organic molecules, we investigated the effects of four compounds naturally occurring in green tea leaves and their equimolar mixtures as inhibitors of insulin fibrillation, with only (-)-epigallocatechin gallate being the active ingredient **[40]**. We have implemented a novel multi-target-directed ligand (MTDL) strategy that focuses on developing a single chemical entity that can modulate multiple targets simultaneously, which can be beneficial for complex amyloid diseases such as AD affecting inappropriately many processes and molecules in the brain. We have found that Chinese herb extracts (sarsapogenin derivatives, tanshinone, salvianolic acid) and 7-methoxytacrine-memantine heterodimers reduce the number of amyloid fibrils and have protective effects on molecules involved in various AD cascades **[41], [42]**.
Cellular membranes consisting of amphiphilic phospholipids may significantly interfere with the amyloid aggregation of proteins. Therefore, the role of various phospholipids was investigated, and the obtained results indicate their active participation in the regulation of amyloid aggregate formation. In case of DMPC and DHPC phospholipid molecules, the inhibitory effect on lysozyme amyloid aggregation was observed. We suggest that this activity is important for forming the amyloid structure within the core of the fibrils due to the blocking of the intermolecular protein interactions. The higher inhibitory activity of DMPC is probably due to the formation of p DMPC micelles allowing the adsorption of lysozyme molecules on their surfaces, which significantly decreases the number of free lysozyme monomer molecules in solution needed for amyloid fibrillization [S. Ponikova et al., Biochimica et Biophysica Acta: general subjects 1861 (2017) 2934]. For other amphiphilic molecules, detergents, the results concluded that amphiphilic molecules are not easily interchangeable in their effect on the amyloid aggregation of proteins **[43], [44]**.

Recently, the study of the nanoparticle interference with amyloid aggregation allowed to clarify the nature of the interactions and evaluated the impact of the nanomaterial behavior on the protein amyloid self-assembly. We have also tested the inhibitory potential of nanoparticles (NPs) (magnetite, gold, silver, polymer, fullerene, dendrimers) with different surface modifications (amino acids, citric acid, poly/saccharides). We found that majority of studied NPs were able to inhibit the formation of lysozyme amyloid aggregates to various extent based on their size and physico-chemical properties. The most effective were magnetite nanoparticles covered by tryptophan, the biggest NPs providing larger surface area for the adsorption of protein molecules as well as aromatic moiety within the tryptophan molecule, which possesses π – π stacking interactions blocking interactions within the

amyloid aggregates **[45]**. Fullerenol C60(OH)16 also represents an effective amyloid inhibitor due to its ability to inhibit amyloid fibrils formation in its early stages by binding to monomer Aβ40 peptide, namely through the interactions with polar, negatively charged amino acids **[46]**. In addition, decrease of the toxic effect of amyloid aggregates on neuroblastoma cells was observed for gold nanoparticles **[47]**.

There is still debate regarding the true pathogenic role of amyloid oligomers and mature fibrils in amyloid-related diseases. Our interdisciplinary approach has brought new knowledge about the relationship between the morphology of aggregates and their cytotoxic effect. Our findings confirm that innocuous monomeric protein can be engineered to produce both cytotoxic soluble prefibrillar aggregates and mature amyloid fibrils, further strengthening the claim that supramolecular structure rather than the identity of the protein is the key to cellular toxicity and the underlying specific cell death mechanism [E. Bystrenova et al., Colloids and Surfaces B – Biointerfaces 161 (2018) 177].

Our studies have gained important insights that will allow a better understanding of the mechanisms of amyloid formation, the toxicity of amyloids on the cells and tissues and contribute to the design of more effective inhibitors as possible therapeutic agents.

The research at the Department of Biophysics has also focused on studying of the conformational states of proteins, mainly with the potential role of oxidative stress in aging processes and age-related diseases. The currently accepted theory suggests that modifying the interactions between major cellular components, proteins, and lipids triggers these diseases. However, convincing evidence of such connection is still lacking. To confirm this hypothesis and explain the role of oxidative stress, a study of the interactions of respiratory chain proteins with phospholipids were performed. The key role of phospholipid cardiolipin in the structural and functional integrity of proteins and the active involvement of mitochondrial complexes in the antioxidant mechanism of the cell has been demonstrated [A. Musatov et al., Biochimie 142 (2017) 102111], **[48]**.

Magnetic nanoparticles have received significant attention in biomedical applications, including cancer diagnostics and treatment. Functionalizing these nanomaterials with specific targeting groups is crucial to enhancing their efficacy in diagnostics and treatments while minimizing the side effects. As almost all solid tumors are hypoxic, have increased metastatic potential, and many are resistant to chemo/radiotherapy, one of the researches is focused on designing and synthesizing amino-functionalized magnetic nanoparticles capable of conjugating specific monoclonal antibodies for cancer cell detection and imaging tumor hypoxia. For conjugation, the mouse monoclonal antibody was selected due to its ability to specifically bind to antigen localized on the surface of cancer cells. Antibody was successfully conjugated to magnetic nanoparticles modified by the various biocompatible amino acids with suitable functional groups accessible for antibody binding. The prepared bioconjugates were tested *in vitro* in 2D and 3D models (spheroids) that reflect the tumor microenvironment more accurately. The results confirmed that bioconjugates were specifically bound to the CA IX antigen localized at the cancer cell surface. Moreover, they were capable of efficient internalization followed by destroying the microstructure of cancer cells **[49], [50]**. The research results have great potential for selective inhibition of cancer cells growth. A significant advance in cancer disease treatment represents the detection of tumor cells mediated by antibodies in combination with MRI. The contrast in MRI is an important factor in proper diagnosis, so finding suitable contrast agents with the highest possible contrast efficiency and the lowest possible toxicity is desirable. Next, our research aimed to investigate the influence of particle diameter as well as the type of functional group present on magnetic nanoparticle surface on the relaxivity properties. The nanoparticles modified by different amino acids (such as glycine, lysine, and tryptophan) **[51]** and by dextran of different molecular weights **[52]** were synthesized and physicochemically characterized with respect to their application in MRI. The results provide an attractive preliminary insight into the impact of magnetic nanoparticle coatings on the transversal relaxivity and contrast efficiency.

Biophysical techniques were also utilized to study another disease, amyotrophic lateral sclerosis (ALS). Gene silencing with virally delivered shRNA represents a promising approach for ALS treatment. The subpial technique **[53]** homogeneously delivers adeno-associated virus (AAV) to brain motor centers using a newly designed device. Experiments on adult animals proved this method as highly effective for AAV-mediated gene delivery

throughout the spinal cord and supraspinal motor centers producing long-term suppression of motoneuron disease, including near-complete preservation of spinal alpha-motoneurons and muscle innervation. Treatment after disease onset potently blocks the progression of the disease and further alpha-motoneuron degeneration. We contributed to this work by developing a special image analysis technique to quantify neuron degeneration levels.

An advanced biophysical technique utilizing a unique optical tweezer device is used to study the viscoelastic characteristics of nanowires prepared by two-photon polymerization. Optical tweezers periodically deformed and released the nanowire. The viscosity was determined using the proposed linear three-parameter solid model from the experimental observation. The effective elastic modulus of the studied nanowires is two orders of magnitude lower than measured for the bulk material **[54]**.

The chemo-biophysical theoretical approaches were also utilized for the modeling of rippled graphene. Based on the different types of hybridization of carbon atom orbitals in the flat and corrugated graphene pieces, we developed the n–p junction model. The orbital dependence on the surface curvature means that the local chemical potential varies with the curvature. In the approximation of the effective mass Hamiltonian, this fact corresponds to the effective electric field that depends on the electron position. This effect becomes important once it is possible to create a graphene system with controlled variation of the surface curvature. Such system can be used in nanoelectronics and optoelectronics **[55]**.

Department of Experimental Chemical Physics

Study of synthetic polymers and supramolecular structures of various types is represented in two papers published in Nature Index journals. The work **[56]** reveals the influence of electrostatic interactions on the propagation rate constants in the polymerization of cationic monomers, obtained by pulsed laser polymerization coupled with size exclusion chromatography. It was found that there are two limiting cases where propagation is governed by different rules. In the case of high concentrations of low molecular weight salt or monomer, the rate is given by the chemical structure of the monomer, while in the case of low concentrations, this rate is dominated by electrostatic repulsive interactions between the growing chain and the reacting monomer.

The second highlight concerns the question of the existence of nanobubbles, which is one of the puzzles of current soft matter physics. On the one hand, the possibility of their existence is denied by theoretical models, on the other hand, there is a large number of experimental studies that describe the presence of nanobubbles in solutions and even in pure water outside interfaces (so-called bulk nanobubbles). The research on nanobubbles is also driven by numerous important envisaged applications. We have critically examined processes of nanobubble generation used in literature, namely the addition of organic substances to water and ultrasonic generation **[57]**.

SPACE and PARTICLE PHYSICS

Department of Space Physics (DSP)

Research groups:

- **Medium and high energy cosmic rays**
- **Low energy cosmic rays**

DSP studies cosmic rays, solar wind, and the Earth's magnetosphere using satellite data and models and provides continuous measurements of cosmic rays using a neutron monitor at the alpine observatory on Lomnický štít.

DSP was involved in the preparation of the new PICAM (Planetary Ion CAMera) device for planetary research **[58]** as part of ESA's ongoing Bepi-Colombo space mission to Mercury from October 2018. Mission will reach parking orbit in 2025. DSP is involved in the development of the PEP scientific apparatus for the ESA JUICE mission to Jupiter and its moons Europa, Ganymede and Callisto. With the support of the ESA PECS Slovakia program (Plan for European Cooperating States), an ACM anti-coincident detector was implemented for this apparatus. The start of the JUICE mission is delayed from 2022 to 2023 due to the COVID pandemic.

DSP is working in the framework of international collaboration on the JEM-EUSO telescope. DSP group focuses mainly on airglow analysis in JEM-EUSO data. In order to demonstrate

key technologies for JEM-EUSO, the EUSO-Balloon instrument was constructed by collaboration. The most relevant participation of DSP group in collaboration leads to article **[59]**, where DSP analyzes the count rates from EUSO-Ballon.
In the field of space weather, the development of detectors [Š. Mackovjak et al., Nuclear Instruments and Methods in Physics Research A922 (2019) 150] and own observations of the thermosphere and ionosphere within the ESA PECS SK2-09 project (AMON-net) continued. Using machine learning techniques, possible disturbances in the interface between space and the Earth's atmosphere were studied [Š. Mackovjak et al., Journal of Geophysical Research: Space Physics 126 (2021) e2020JA028991], **[60]**. Following these activities, new projects ESA PECS SK6-29 (ASPIS) and ESA AD03 (SK-S2P) received funding.
In the field of cosmic ray modeling, DSP research is mainly devoted to the modulation and distribution of cosmic radiation in the heliosphere **[61], [62], [63]** and the motion of cosmic ray particles in the Earth's magnetosphere.
An important part of the activities at the DSP IEP SAS is the implementation of continuous ground measurements at the observatory on Lomnický štít. At the observatory, it is possible to perform unique measurements of cosmic phenomena [(K. Kudela et al., Journal of Geophysical Research: Atmospheres 122 (2017) 10700] that cannot be performed elsewhere in Central Europe. Neutron monitor measurements (continually in operation from December 1981) [K. Kudela et al., Science China Technological Sciences 59 (2016) 547] and SEVAN measurements (from March 2014) **[64]** are especially important. In the field of applied science, DSP cooperates with the Institute of Nuclear Physics of the Czech Academy of Sciences in the field of radiation protection from cosmic rays, and actively participates on research of space weather from radiation protection point of view [J. Kubančák et al., Radiation Protection Dosimetry (2021)].
In recent theoretical studies at IEP SAS, two interesting and surprising results were achieved, with the potential to change common paradigms in cosmology and particle physics. The first result **[65]** shows that by introducing a special type of space (so-called PNDP manifold Partially Negative Dimensional Product) containing also negative dimensions, seemingly unrelated phenomena such as e.g. strings in particle physics, superposition of particles, dark matter in cosmology or paradoxes associated with wormhole travel) can be explained and moreover connected. Also, an important result is the definition of the formation of the string itself as a fundamental unit of matter by the interaction between positive and negative dimensions. The second result [R. Pincak et al., International Journal of Geometric Methods in Modern Physics 18 (2020) 2150227] uses the PNDP manifold to describe D-Branes known from string theory and shows the discrete nature of space and time, as well as the possibility of how to prove it.

Department of Subnuclear Physics

Research groups:

- **Experiment ATLAS at the LHC accelerator in CERN**
- **Experiment ALICE at the LHC accelerator in CERN**

Between 2016 and 2021 the experimental particle physics research was concentrated mainly on the two experiments at the Large Hadron Collider at CERN: ALICE and ATLAS. Evaluation period covered the second long data taking period at LHC (Run-2) and its 2nd long shutdown. The ALICE experiment was designed with the emphasis on the study of nonperturbative QCD physics and investigation of the properties of the quark-gluon plasma. During data taking period IEP SAS group was responsible for the maintenance and operation of the Central Trigger Processor (CTP), the on-luminosity monitoring and also for the data taking during van der Meers scans provide data for the measurement of normalization cross section. The long shutdown at ALICE was dedicated to the major detector upgrade. IEP SAS contributed to the upgrade of the CTP - development of electronics, production and testing of cables, and hardware debugging, upgrade of the Inner Tracking System - participation in commissioning measurements, and development of new software for the LHC Interface. For the absolute normalization of measured observable one needs precisely measured normalization cross section measured using the method of van der Meer scans. For the vdM data analysis IEP SAS group contributed by the data taking software, preparation of data sets and providing corrections for the beam-beam interactions. After the end of the data

taking period, all major LHC experiments created a joint working group with a common goal to better understand the beam-beam interactions in order to increase precision of the all published data. IEP SAS contributed by development and evaluation of software and by numerical simulations. Another direction of the physics analysis was the study of the strange particles production in Pb-Pb collisions at √s=5.02 TeV **[66]** and p-p at √s=7 and 13 TeV **[67]**. A study of strangeness production in high multiplicity p-p collisions at √s=7 TeV revealed a presence of the strangeness enhancement with the charge particle multiplicity, an effect thought to be present only in nucleus-nucleus collisions, also in smaller systems line p-p or p-Pb **[68]**.

The ATLAS experiment is optimized to study the strong and electro-weak processes, main responsibility of IEP SAS group is the calibration, software and data preparation for Liquid Argon Calorimeter (LAr) of ATLAS detector, which measures the electromagnetic particles (electrons and photons) with unprecedented precision. Group was responsible for developing and maintenance of all the software tools needed to keep the high quality and precise calibration of data from LAr. The resulting 99.9% of LAr data good for physics in LHC Run-2 was the main achievement of the group. That is directly reflected in all cited publication **[69], [70]**. During the long shutdown, group has participated on migration of the software tools to a new multithreaded framework, as well as on validation of all new components. The group is also involved in developing of topological clustering algorithm **[71]**. In recent years group have also participated on physics analysis of spin correlations in top-antitop decays, which is an important and precise test of Standard Model. The quest for highest possible LHC luminosity that detector can handle lead to development of a new electronic chips capable of work in a radiation hard environment. In collaboration with Nevis Laboratories at Columbia University, USA, several chips that could reach this goal were developed for the future ATLAS Liquid Argon calorimeter.

Within the phenomenology of elementary particles, we have studied manifestations of nuclear effects in production of Drell-Yan pairs off nuclei as well as in production of heavy flavoured mesons in heavy ion collisions **[72]**. Production of dilepton pairs and direct photons off nuclei is not affected by any final state interactions, energy loss, or absorption. This allows us to investigate manifestations of Initial-State-Interaction (ISI) effects in proton-nucleus collisions. We have also analysed various theoretical uncertainties, which affect the phenomenological description of diffractive electroproduction of heavy quarkonia within colour dipole formalism frequently used in the literature. Within the colour dipole formalism, we have studied a correlation between dipole orientation and impact parameter of a collision **[73]** in diffractive electroproduction of heavy quarkonia on proton targets for the first time.

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 (in percentage)

Type of the research outputs:

Basic research: 90 %

Applied research: 10 %

International: 100 %

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.

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Available at: https://doi.org/10.1103/PhysRevD.96.014010

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Principal results excluding large-scale scientific collaborations:

ČLOVEČKO, Marcel - GAŽO, Emil - KUPKA, Martin - SKYBA, Peter**. Magnonic Analog of Black- and White-Hole Horizons in Superfluid He-3-B. In *Physical Review Letters*, 2019, vol. 123, no. 16, art. no. 161302. (2018: 9.227 - IF, Q1 - JCR, 3.571 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
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RAK, Dmytro - OVADOVÁ, Michaela - SEDLÁK, Marián**. (Non)Existence of Bulk Nanobubbles: The Role of Ultrasonic Cavitation and Organic Solutes in Water. In *Journal of Physical Chemistry Letters*, 2019, vol. 10, no. 15, p. 4215-4221. (2018: 7.329 - IF, Q1 - JCR, 3.618 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 1948-7185. Available at: https://doi.org/10.1021/acs.jpclett.9b01402

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Available at: https://doi.org/10.3390/universe7030075

Principal results from large-scale scientific collaborations:

ADAM, J. - ADAMOVÁ, D. - AGGARWAL, M.M. - AGLIERI RINELLA, G. - AGNELLO, M. - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - MUŠINSKÝ, Ján - VAĽA, M. Enhanced production of multi-strange hadrons in high-multiplicity proton–proton collisions. In *Nature Physics*, 2017, vol. 13, no. 6, p. 535-539. (2016: 22.806 - IF, Q1 - JCR, 13.412 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 1745-2473.
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AAD, G. - ABBOTT, B. - ABDALLAH, J. - ABDINOV, O. - ABELOOS, B. - ANTOŠ, Jaroslav - BRUNCKO, Dušan - KLADIVA, Eduard - STRÍŽENEC, Pavol. Measurements of the Higgs boson production and decay rates and constraints on its couplings from a combined ATLAS and CMS analysis of the LHC pp collision data at root s=7 and 8 TeV. In *Journal of High Energy Physics*, 2016, vol. 2016, no. 8, art. no. 045. (2015: 6.023 - IF, Q1 - JCR, 1.343 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 1029-8479.
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2.1.3 List of monographs/books published abroad

[1] LUKÁČOVÁ BUJŇÁKOVÁ, Z. - SHPOTYUK, O. - DUTKOVÁ, E. - TÓTHOVÁ, E. - KOVÁČ, Jozef - KELLO, M. - BALÁŽ, M. - BALÁŽ, P. Processing of natural mineral magnetite for medical applications. In *Biocompatible Hybrid Oxide Nanoparticles for Human Health*. - Eastbourne, UK: Elsevier, 2019, p. 125-147. ISBN 978-0-12-815875-3, Type: ABC

[2] PINČÁK, Richard - BARTOŠ, E. Application of Spin-Orbit Coupling in Exotic Graphene Structures and Biology. In Solid State Physics. Metastable, Spintronics Materials and Mechanics of Deformable Bodies - Recent Progress. - London, United Kingdom: IntechOpen, 2020, p. 95 - 114. ISBN 978-1-83881-164-8.
https://www.intechopen.com/books/solid-state-physics-metastable-spintronics-materials-and-mechanics-of-deformable-bodies-recent-progress/application-of-spin-orbit-coupling-in-exotic-graphene-structures-and-biology, Type: ABC

2.1.4. List of monographs/books published in Slovakia

[1] VARGOVÁ, Hana. Počítačová fyzika a modelovanie [elektronický zdroj]. Recenzenti: Marián Reiffers, Peter Markoš, Martin Bača. Košice: Ústav experimentálnej fyziky SAV, 2019. 110 s. https://home.saske.sk/~hcencar/. ISBN 978-80-89656-24-0, Type: ACB

[2] KOPČANSKÝ, Peter - TIMKO, Milan - STUDENYAK, I.P. - KOVALCHUK, O.V. *Nanoparticles in homogeneous, micro- and nanometric structures based on liquid crystals: morphology and dielectric properties* = Nanočastinki v gomogennich mikro-ta nanorozmirnich pidkokristaličnych strukturach morfologija ta dielektrični vlastnosti. Košice: Institute of Experimental Physics Slovak Academy of Sciences, 2020. 199 s. ISBN 978-80-8143-275-0, Type: AAB

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

Contribution to development of science suite SERENA (Search for Exospheric Refilling and Emitted Natural Abundances) for ESA-**BepiColombo mission to planet Mercury**. The Institute was particularly involved in development of the ion mass spectrometer PICAM (Planetary Ion CAMera). Cooperation with Institute for Space Research, Austria (Institut für Weltraumforschung, IWF, Graz) and Space Technology Ireland (STIL) at Maynooth University, Ireland.

Contribution to development of science suite PEP (Particle Environment Package) for ESA-**JUICE mision** (JUpiter ICy moons Explorer) **to planet Jupiter** and its moons Europa, Ganymede and Callisto. The Institute was particularly involved in development of the anti-coincidence detection module ACM for PEP's JDC detector (Jovian plasma Dynamics and Composition). Cooperation with Institute of Space Physics (Institutet för rymdfysik, IRF, Kiruna), Sweden.

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

Registered patents:

Number: US 10.922.899 B2 (2021)
Authors: Tomori Z.
Invention title: Method of interactive quantification of digitized 3D objects using an eye tracking camera
Owner/co-owner: IEP SAS, Košice
Country: USA

Number: UA 111241 (2016)
Authors: Studenyak I.P., Kovalchuk O.V., Bendak A.V., Studenyak V.I., Kopčanský P., Timko M.
Invention title: Method of electrical conductivity increase of 6CHBT nematic liquid crystal by introduction of nanoparticles Cu_6PS_5I superionic conductor
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 124745 (2018)
Authors: Studenyak I.P., Kovalchuk O.V., Izai V.Yu., Vizenko M.O., Kopčanský P., Timko M.
Invention title: Method of electrical conductivity increasing in 6CB liquid crystal by introducing of Cu_7PS_6 superionic conductor nanoparticles
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 116679 (2018)
Authors: Studenyak I.P., Kovalchuk O.V., Bendak A.V., Studenyak V.I., Kopčanský P., Timko M.
Invention title: Method of composite obtaining based on nematic 6CHBT liquid crystal
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 127636 (2018)
Authors: Studenyak I.P., Izai V.Yu., Pogodin A.I., Rajňák M., Timko M., Kopčanský P.
Invention title: Application of polymer composite based on microcrystalline Cu_7GeS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 141049 (2020)
Authors: Studenyak I.P., Kovalchuk O.V., Studenyak V.I., Pogodin A.I., Oleynikova I.V., Kopčanský P., Timko M.
Invention title: Method of electrical conductivity increasing of 6CB liquid crystal with embedded nanoparticles of Ag_7GeS_5I superionic conductor
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 121782 (2020)
Authors: Studenyak I.P., Izai V.Yu., Pogodin A.I., Rajňák M., Timko M., Kopčanský P.
Invention title: Application of polymer composite based on microcrystalline Cu_7GeS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 144411 (2020)
Authors: Studenyak I.P., Bereznyuk C.M., Pogodin A.I., Kokhan O.P., Timko M., Kopčanský P.
Invention title: Application of superionic ceramic based on microcrystalline Cu_7SiS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 144770 (2020)
Authors: Studenyak I.P., Bereznyuk C.M., Pogodin A.I., Kokhan O.P., Timko M., Kopčanský P.
Invention title: Application of polymer composite based on microcrystalline Cu_7SiS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 145891 (2021)
Authors: Studenyak I.P., Pogodin A.I., Studenyak V.I., Kokhan O.P., Timko M., Kopčanský P.
Invention title: Application of polymer composite based on microcrystalline Ag_7GeS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Number: UA 146789 (2021)
Authors: Studenyak I.P., Shender I.O., Pogodin A.I., Kokhan O.P., Kopčanský P.
Invention title: Application of polymer composite based on microcrystalline Ag_7SiS_5I as a material for solid electrolyte power source
Owner/co-owner: Uzhhorod State University
Country: Ukraine

Patent applications:

Number: EP15710288.0 (2016)
Authors: Sedlák M., Rak D.
Invention title: A method for determination of content of hydrophobic compounds in water-miscible organic liquids
Owner/co-owner: IEP SAS, Košice
Country: Europe

Number: EP17160213.9 (2017)
Authors: Sedlák M., Rak D.
Invention title: A method for purification of water soluble compounds from hydrophobic contaminants
Owner/co-owner: IEP SAS, Košice
Country: Europe

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

Registered patents:

Number: 288468 (2017)
Authors: Diko P., Volochová D.
Invention title: Binnary doped singlegrain YBCO superconductor
Owner/co-owner: IEP SAS, Košice

Number: 288560 (2018)
Authors: Sedlák M., Rak D.
Invention title: Measurement of the alkane content in alcohols by the method of nanoseggregation in aqueous solutions
Owner/co-owner: IEP SAS, Košice

Number: 288766 (2020)
Authors: Sedlák M., Rak D.
Invention title: Measurement of the content of hydrophobic compounds in water-miscible organic liquids
Owner/co-owner: IEP SAS, Košice

Patent applications:

Number: PP 50015 (2016)
Authors: Sedlák M., Rak D.
Invention title: A method for purification of in water soluble compounds from hydrophobic contaminants
Owner/co-owner: IEP SAS, Košice

Number: PP 50137 (2019)
Authors: Diko P., Hajdová P.
Invention title: GdBCOAg homogeneous massive superconductor
Owner/co-owner: IEP SAS, Košice

Number: PP 50062 (2021)
Authors: Rajňák M., Dolník B.
Invention title: Energy-efficient device for measuring magneto-dielectric response
Owner/co-owner: Technical University in Košice, IEP SAS, Košice

2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

Cryogenic impurity detector for liquid ^{4}He. Many low-temperature research laboratories around the world have suffered from blocking of fine-capillary tubes, which are necessary to achieve temperatures below 4.2 K. It was shown in [M. Gabal et al., Physical Review Applied 6 (2016) 024017], that the physical mechanism responsible for the blockage of capillary is based upon the freezing of molecular H_2 traces present in liquid helium. Considering a molecular hydrogen trace amount of about 0.1 ppm, its detection by conventional spectroscopic methods is intricate and unreliable. The designed and built cryogenic impurity detector for liquid helium is based on accumulation of solid H_2 at the low-pressure impedance side of a capillary. The constructed detector allowed us to detect contaminated liquid helium, which affected the low-temperature operation performance of several cryogenic devices at the Institute of Experimental Physics in Košice. Using this detector we can check the purity of liquid helium before it is used for cooling in cryogenic facilities. Moreover, the detector is suitable not only for hydrogen detection, but also for other impurities as e.g.

nitrogen, oxygen and water. Developed detector and know-how of very sensitive gas detection can be used not only in our institute but wherever it is needed.

Development of the experimental technique for measurement of very low temperatures in high magnetic fields. We have found and presented the performance of commercial Quartz Tuning Forks (QTFs) operating at resonance frequencies of 32 kHz, 77 kHz, and 100 kHz in the temperature range below 1 K and in high magnetic fields up to 7.5 T [1, 2]. It was shown that characteristics of the quartz tuning forks, in particular, the normalized QTF resonance frequency, manifests universal temperature dependence, which is independent on magnetic field strength. This feature makes the QTFs very promising low-temperature thermometers in high magnetic fields in the temperature range below 1 K having a B/T ratio up to 1000. We also discussed the physical origin of the observed dependencies.
[1] ČLOVEČKO, Marcel - SKYBA, Peter**. Quartz tuning fork-A potential low temperature thermometer in high magnetic fields. In *Applied Physics Letters*, 2019, vol. 115, no. 19, art. no. 193507. (2018: 3.521 - IF). (2019 - Current Contents, WOS, SCOPUS). ISSN 0003-6951.
[2] *SciLight* (https://aip.scitation.org/doi/10.1063/10.0000260).

Prototype of nuclear stage for commercial cryogen-free refrigerators. Rapid development and commercialization of the cryogen-free cooling techniques led to accessibility of low temperatures, including millikelvin temperatures, for broad spectrum of scientists. In consequence, there is also demand for a ”commercialization” and access to much lower temperatures – in microkelvin regime. As a part of European Microkelvin Platform project we have been developing a robust classical copper nuclear stage for commercial cryogen-free refrigerators. Aim of the stage design is ”plug-in and cool down”. Designed copper nuclear stage can easily be connected to the mixing chamber plate of commercially available cryogen-free dilution refrigerators, it has own small superconducting magnet controlling the state of the aluminium heat switch and two ”very cold plates” with an extension capability to perform experiments in sub-millikelvin temperature regime. In addition, we have been developing a small, almost commercial Pt NMR thermometer capable of measuring temperatures in sub-millikelvin range.

Determination of the spin polarization in nanowires. A new experimental approach has been developed to determine the spin polarization in nanowires [1]. This method is based on point-contact Andreev-reflection spectroscopy measurements directly on the array of nanowires and not in separated nanowires. Using this method, we have shown, that Co_2FeSn Heusler nanowires reveal high spin polarization near 100% or even half metallicity, which is very promising in spintronics applications.
[1] GALDUN, L.** - SZABÓ, Pavol - VEGA, V. – BARRIGA-CASTRO, E.D. - MENDOZA-RESÉNDEZ, R. - LUNA, C. - KOVÁČ, Jozef - MILKOVIČ, Ondrej - VARGA, R. - PRIDA, V.**. High Spin Polarization in Co2FeSn Heusler Nanowires for Spintronics. In *ACS Applied Nano Materials*, 2020, vol. 3, no. 8, p. 7438-7445. (2019: 1.079 - SJR). (2020 - Current Contents). ISSN 2574-0970.

Ferritin is iron storage protein in human body related to neurovegetative diseases such as Parkinson´s and Alzheimer´s diseases, i.e. during creation of these diseases in ferritin transformation of oxidative states of iron occurs (change from nontoxic Fe^{3+} to toxic Fe^{2+}). This is connected with occurrence of magnetite and/or maghemite. Development of magnetooptical and NMR methods to quantify such transformation (results contribute better to diagnostics of these diseases as well to therapeutic strategies) is described in [1]. Second most important result concerns polychlorinated biphenyls, synthetic industrial organic substances, which are described in paper [2]. These persistent pollutants occur in nature causing high ecological risks and damage to human health. Magnetoferritin nanoparticles composed of apoferritin protein shell surrounding synthetically prepared iron-based nanoparticles seem to be a promising candidate for polychlorinated biphenyls (PCB) elimination. Slovakia has a big problem with such eliminations of PCB, among the examples we can mention Chemko Strazske chemical factory in east Slovakia.
[1] KORALEWSKI, M. ** - BALEJČÍKOVÁ, Lucia - MITRÓOVÁ, Zuzana - POCHYLSKI, M. - BARANOWSKI, M. - KOPČANSKÝ, Peter. Morphology and Magnetic Structure of the Ferritin

Core during Iron Loading and Release by Magnetooptical and NMR Methods. In *ACS Applied Materials & Interfaces*, 2018, vol. 10, no. 9, p. 7777-7787. (2017: 8.097 - IF). (2018 - Current Contents). ISSN 1944-8244.
[2] BALEJČÍKOVÁ, L.** - TOMAŠOVIČOVÁ, Natália - ZAKUŤANSKÁ, Katarína - BAŤKOVÁ, Marianna - KOVÁČ, Jozef - KOPČANSKÝ, Peter. Dechlorination of 2,4,40-trichlorobiphenyl by magnetoferritin with different loading factors. In *Chemosphere*, 2020, vol. 260, art. no. 127629. (2019: 5.778 - IF). (2020 - Current Contents). ISSN 0045-6535.

The tears of people with major depressive disorder, or clinical depression, have a different chemical composition than the tears of nondepressed people, according to a recent study that highlighted tear fluid´s potential for the simple, rapid diagnosis of mood disorders. Tear fluid is considered a source of biomarkers, which are seen as indicators of normal biological processes that can be objectively measured, similar to blood count. In [1] a group of researchers from Slovakia explored how the analysis of tear fluid may facilitate the diagnosis of mood disorders, such as depression or bipolar disorder, and has potential for future integration in bioinformatic pipelines and personalized medicine.
[1] KRAJČÍKOVÁ, K. - SEMANČÍKOVÁ, E.** - ZAKUŤANSKÁ, Katarína - KONDRAKHOVA, D. - MAŠLANKOVÁ, J. - STUPÁK, M. - TALIAN, I. - TOMAŠOVIČOVÁ, Natália - KIMÁKOVÁ, T. - KOMANICKÝ, V. - DUBAYOVÁ, K. - BREZNOŠČÁKOVÁ, D. - PÁLOVÁ, E. - SEMANČÍK, J. - TOMEČKOVÁ, V. Tear fluid biomarkers in major depressive disorder: Potential of spectral methods in biomarker discovery. In *Journal of Psychiatric Research*, 2021, vol.138, p. 75-82. (2020: 4.791 - IF). (2021 - Current Contents). ISSN 0022-3956.

Development of the chip for the transfer of trigger data for the ATLAS experiment. A radiation hardened chip with serialization logic and two 4.8 GHz serial data channels was developed as a part of a broader effort to develop a new chip set capable of work in hard radiation environment of the ATLAS Liquid Argon calorimeter. The high energy and particle physics present very demanding environment pushing boundaries of the cutting-edge technology, that might need a couple of years to find its way into non-scientific applications.

The investigation of effect of cerium dioxide addition on the structure and superconducting properties of GdBCO-Ag-Ce bulk singlegrain superconductors by methods of thermal analysis, X-ray analysis, scanning electron and optical microscopies, magnetization measurements. We were the first to show that the added cerium dioxide suppresses barium/gadolinium substitution in the crystal lattice of the superconducting $Gd(Ba_{1-y}Gd_y)_2Cu_3O_x$ compound, thereby increasing the critical superconducting transition temperature and regulating the concentration of nanoscale pinning centres of magnetic flux lines. The addition of cerium dioxide can thus increase the homogeneity of the superconducting transition temperature within the bulk singlegrain superconductor and optimize the critical current density at higher magnetic fields. The found effect of cerium dioxide addition on the superconducting properties of GdBCO-Ag-Ce bulk singlegrain superconductors is the subject of a patent application. We anticipate the use of the acquired knowledge in the framework of cooperation with the manufacturer of bulk singlegrain superconductors CAN Superconductors a.s.

Amorphous and nanocrystalline ribbons exhibiting giant magnetoimpedance effect (GMI) were subject of our intense research due to their applications in GMI magnetic sensors [1]. Strategies for enhancement of their GMI performance include utilization of new alloy compositions, better control of microstructure and improved processing techniques. We have demonstrated a novel approach for improving the high frequency magnetoimpedance response of FeNi-based soft magnetic nanocrystalline ribbons by coating them with Co thin films showing transverse anisotropy. The impact of Co coating on the high frequency impedance was studied with techniques sensitive to surface magnetism, namely magneto-optical Kerr effect (MOKE), MOKE microscopy, and high frequency impedance as a function of magnetic field. Our study provides important insights into the effects of interaction between layers on the magnetoimpedance behaviour in such soft magnetic layered structures, which can be used in design of highly sensitive GMI sensors.

[1] EGGERS, T.** - LAM, D.S. - THIABGOH, O. - MARCIN, Jozef - ŠVEC, P. - HUONG, N.T. - ŠKORVÁNEK, Ivan** - PHAN, M.H.**. Impact of the transverse magnetocrystalline anisotropy of a Co coating layer on the magnetoimpedance response of FeNi-rich nanocrystalline ribbon. In *Journal of Alloys and Compounds*, 2018, vol. 741, p. 1105-1111. (2017: 3.779 - IF). (2018 - Current Contents, WOS, SCOPUS). ISSN 0925-8388).

Recently, the **diagnostic of amyloid-related diseases** in their early stages is very difficult despite intensive studies in this area. We have investigated if changes in the biochemical and biophysical parameters (fluorescence, surface tension) of human biological fluids (cerebrospinal fluid, blood plasma, serum) may serve for laboratory and clinical early diagnostics of Alzheimer´s disease (AD). We have found correlation between the fluorescence in presence of dye thioflavin T or magnetic nanoparticles, the fluorescence of untreated sample and levels of protein phospho-tau detected for cerebrospinal fluid or serum appears to be an acceptable supportive diagnostic biomarker for AD. On the other hand, we evaluated the surface tension values of biological fluids, yet despite a great promise they are not a suitable biomarker for diagnostic of this disease [1]. The fluorescence intensity measurements can be recommended for AD diagnosis since it is a relatively cheap and easily accessible approach.
[1] GAŽOVÁ, Zuzana - BEDNÁRIKOVÁ, Zuzana - BARTOŠ, A. - KLASCHKA, J. - KRIŠTOFIKOVÁ, Z.**. Surface tension and intrinsic amyloid fluorescence of serum and cerebrospinal fluid samples in Alzheimer's disease. In *Biomarkers in Medicine*, 2019, vol. 13, no. 4, p. 267-277. ISSN 1752-0363

Identification of the novel compounds as potential drugs for treatment of amyloid-related diseases. The classic drug-design strategy based on the “one-molecule-one-target” paradigm was found to be ineffective in the case of multifactorial amyloid-related diseases like Alzheimer´s disease (AD). A novel multi-target directed ligand strategy based on the assumption that a single compound consisting of two or more distinct pharmacophores is able to hit multiple targets has been proposed as promising. With respect to multi-target theory we designed a new classes of multitarget compounds – hybrid heterodimers - and evaluated their ability to affect several targets associated with AD involved in amyloid, cholinergic and acetylcholine cascades. The multitarget effect, namely the amyloid inhitory, antioxidant, chelating and free radical scavening activities, was observed for tacrine/acridone-coumarin and 7-MEOTA-adamantyl amine heterodimers [1-3]. Based on the detailed analysis of the relationship between the structure of the effective small compound CID 9998128 and its multitarget activities we predict that the chemical structure of potent AD multitarget compounds should not contain indazole [4]. The effective compounds are prominent candidates for multitarget therapy of AD and other amyloid-related diseases.
[1] HAMULÁKOVÁ, S. - POPRAC, P. - JOMOVÁ, K. - BREZOVÁ, V. - LAURO, P. - DROSTINOVÁ, L. - JUN, D. - SEPSOVÁ, V. - HRABINOVÁ, M. - SOUKUP, O. - KRISTIÁN, P. - GAŽOVÁ, Zuzana - BEDNÁRIKOVÁ, Zuzana - KUČA, K. - VALKO, M.**. Targeting copper(II)-induced oxidative stress and the acetylcholinesterase system in Alzheimer's disease using multifunctional tacrine-coumarin hybrid molecules. In *Journal of Inorganic Biochemistry*, 2016, vol. 161, p. 52-62. (2015: 3.205 - IF). (2016 - Current Contents). ISSN 0162-0134.
[2] GANČÁR, Miroslav - HO, K. - MOHID, Sk.A. - THAI, N.Q. - BEDNÁRIKOVÁ, Zuzana - NGUYEN, H.L. - BHUNIA, A. - NEPOVIMOVA, E. - LI, M.S.** - GAŽOVÁ, Zuzana**. 7-Methoxytacrine and 2-Aminobenzothiazole Heterodimers: Structure-Mechanism Relationship of Amyloid Inhibitors Based on Rational Design. In *ACS Chemical Neuroscience*, 2020, vol. 11, no. 5, p. 715-729. (2019: 4.486 - IF). (2020 - WOS, SCOPUS). ISSN 1948-7193.
[3] ULIČNÁ, Katarína - BEDNÁRIKOVÁ, Zuzana - HSU, W.-T. - HOLZTRAGEROVA, M. - WU, J.W. - HAMULÁKOVÁ, S. - WANG, S.S.S.** - GAŽOVÁ, Zuzana**. Lysozyme amyloid fibrillization in presence of tacrine/acridone-coumarin heterodimers. In *Colloids and Surfaces B - Biointerfaces*, 2018, vol. 166, p. 108-118. (2017: 3.997 - IF). (2018 - Current Contents, WOS, SCOPUS). ISSN 0927-7765.
[4] THAI, N.Q. - BEDNÁRIKOVÁ, Zuzana - GANČÁR, Miroslav - LINH, H.Q. - HU, C.-K.** - LI, M.S.** - GAŽOVÁ, Zuzana**. Compound CID 9998128 Is a Potential Multitarget Drug for

Alzheimer's Disease. In *ACS Chemical Neuroscience*, 2018, vol. 9, no. 11, p. 2588-2598. (2017: 4.211 - IF). (2018 - WOS, SCOPUS). ISSN 1948-7193.

The concept of so-called **mesoscale solubility** was elaborated [1], reflecting the fact that solubility in nature is achieved not only by the well-known “like likes like” or “like dissolves like” based on molecular solvation but also by mesoscale solubilization of dislike compounds characterized in that the solubility (homogeneous distribution over the whole volume of the system) is achieved on a mesoscale level ranging from tens to hundreds of nanometers [1]. The "meso" indicates that these are scales larger than molecular and smaller than macroscopic. Also, several patents and patent applications were based on this concept [2-5]. It was a method of measuring the content of hydrophobic substances (contaminants) in water soluble compounds [2-4]. The measurement method according to the invention is based on the finding that hydrophobic contaminants, after mixing the compound with water, segregate into discrete, stable mesoscale structures (nanoparticles/nanodroplets) whose number concentration, size and density correlate with the content of contaminants in the test compound, which is subsequently quantified by static laser light scattering method. Subsequent research revealed that the resulting nanoparticles/nanodroplets are sufficiently mechanically strong and stable in shape to be subsequently eliminated by nanofiltration without the need to add any additives as nanoparticle/nanodroplet stabilizers and subsequent contamination of the mixture with these additives. This allowed us to develop a new process of purification of organic water-soluble substances from hydrophobic contaminants to high degrees of purity of substances (below 1 ppm) [5]. Both methods are relatively simple, inexpensive, and fast.

Prototype of a device for hydrophobic contaminants screening. Based on the patented method of measuring the content of hydrophobic substances (contaminants) in water soluble compounds [2-4], we have developed a measuring device capable to measure contaminant concentrations in the range of 5ppm - 10^3ppm, while this range can be extended to 50ppb - 10^5ppm by sample pre-treatment. Since our device determines the total content of hydrophobic contaminants (not specific contaminants), we refer it to as a device for hydrophobic contaminants screening. This is similar to the massively used TOC (Total Organic Carbon) equipment used in water analysis, where only total carbon is determined, not specific contaminants. If the TOC value exceeds a certain acceptable level, identification of specific contaminants is followed, which is a far more complicated and expensive process. Our device is based on laser scattering using a solid-state compact diode laser and three-channel detection (at three scattering angles) based on silicon diodes and analog-to-digital signal conversion. It comes with dedicated software for measurement and calibration. Main advantages represent low cost, low operation expenses, relatively simple operation, high sensitivity, and portable size. Photos and schemes related to this device can be found in the attachment to this questionnaire.

[1] RAK, Dmytro – SEDLÁK, Marián**. On the Mesoscale Solubility in Liquid Solutions and Mixtures. In *Journal of Physical Chemistry B*, 2019, vol. 123, no. 6, p. 1365-1374. (2018: 2.923 – IF). (2019 – Current Contents, WOS, SCOPUS). ISSN 1520-6106.

[2] SEDLÁK, Marián – RAK, Dmytro. Measurement of the alkane content in alcohols by the method of nanoseggregation in aqueous solutions. Industrial Property Office of the Slovak Republic, patent number 288560, 2018

[3] SEDLÁK, Marián – RAK, Dmytro. Measurement of the content of hydrophobic compounds in water-Miscible Organic Liquids. Industrial Property Office of the Slovak Republic, patent number 288766, 2020

[4] SEDLÁK, Marián – RAK, Dmytro. A Method for Determination of Content of Hydrophobic Compounds in Water-Miscible Organic Liquids, European Patent Office, application EP15710288.0, 2016

[5] SEDLÁK, Marián – RAK, Dmytro. A method for purification of water soluble compounds from hydrophobic contaminants. European Patent Office, application EP17160213.9, 2017

Systematic study of flexible microstructures fabricated by 2-photon polymerization resulted in new possibilities to measure **viscosity in “Lab-on-chip” applications** as described in [1]. The **expertise in image analysis** was exploited in long-term international cooperation with UCSD, San Diego leading to participation in relevant publication [2], where we perform the

morphometric analysis of sciatic nerve and spinal cord lateral funiculus area. The software automatically recognizes myelinated axonal profiles allowing manual correction of missing or incorrectly detected objects.
[1] KUBACKOVÁ, Jana - SLABÝ, C. - HORVÁTH, D. - HOVAN, A. - IVÁNYI, G.T. - VIZSNYICZAI, G. - KELEMEN, L. - ŽOLDÁK, G. - TOMORI, Zoltán - BÁNÓ, G.**. Assessing the Viscoelasticity of Photopolymer Nanowires Using a Three-Parameter Solid Model for Bending Recovery Motion. In *Nanomaterials-Basel*, 2021, vol. 11, no. 11, art. no. 2961. (2020: 5.076 - IF). (2021 - Current Contents, WOS, SCOPUS). ISSN 2079-4991.
[2] BRAVO-HERNANDEZ, M. - ... - TOMORI, Zoltán - ... - MARSALA, M.**. Spinal subpial delivery of AAV9 enables widespread gene silencing and blocks motoneuron degeneration in ALS. In *Nature Medicine*, 2020, vol. 26, no. 1, p.118-130. (2019: 36.130 - IF). (2020 - Current Contents). ISSN 1078-8956.

In recent theoretical studies, two interesting and surprising results were achieved, with the potential to **change common paradigms in cosmology and particle physics**. The first result [1] shows that by introducing a special type of space (so-called PNDP manifold Partially Negative Dimensional Product) containing also negative dimensions, seemingly unrelated phenomena such as e.g. strings in particle physics, superposition of particles, dark matter in cosmology or paradoxes associated with wormhole travel) can be explained and moreover connected. Also, an important result is the definition of the formation of the string itself as a fundamental unit of matter by the interaction between positive and negative dimensions. The second result [2] uses the PNDP manifold to describe D-Branes known from string theory and shows the discrete nature of space and time, as well as the possibility of how to prove it. Both results were achieved within the framework of international cooperation, where the first and at the same time corresponding author was Richard Pinčák. These results are important for a full understanding of the nature of the universe as well as parallel interacting universes.
[1] PINČÁK, Richard** - PIGAZZINI, A. - JAFARI, S. - OZEL, C. The “Emerging” Reality from “Hidden” Spaces. In *Universe*, 2021, vol. 7, no. 3, art. no. 75. (2020: 2.278 - IF). (2021 - Current Contents, WOS, SCOPUS). ISSN 2218-1997.
[2] PINČÁK, Richard** - PIGAZZINI, A. - JAFARI, S. - OZEL, C. - DEBENEDICTIS, A. A topological approach for emerging D-branes and its implications for gravity. In *International Journal of Geometric Methods in Modern Physics*, 2021, vol. 18, no. 14, art. no. 2150227. (2020: 1.874 - IF). (2021 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0219-8878.

2.1.9. Table of research outputs

Papers **with international collaborations** in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS Collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration):

Average FTE researchers per year = 69.50

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.015	0.376	0	0.000	0.000	**1**	**0.167**	**0.002**	**0.076**
Chapters in scientific monographs published abroad *(ABC)*	0	0.000	0.000	0	0.000	0.000	**0**	0.000	0.000	1	0.015	0.426	0	0.000	0.000	0	0.000	0.000	**1**	**0.167**	**0.002**	**0.076**
Chapters in scientific monographs published in Slovakia *(ABD)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	238	3.106	137.764	264	3.677	143.196	246	3.660	126.798	219	3.215	93.255	259	3.874	97.285	177	2.667	68.987	**1 403**	**233.833**	**3.365**	**107.200**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	23	0.300	13.313	26	0.362	14.103	11	0.164	5.670	20	0.294	8.516	15	0.224	5.634	9	0.136	3.508	**104**	**17.333**	**0.249**	**7.946**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	0	0.000	0.000	0	0.000	0.000	2	0.030	1.031	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**2**	**0.333**	**0.005**	**0.153**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0	0.000	0.000	1	0.014	0.542	0	0.000	0.000	2	0.029	0.852	0	0.000	0.000	0	0.000	0.000	**3**	**0.500**	**0.007**	**0.229**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	0	0.000	0.000	0	0.000	0.000	2	0.030	1.031	2	0.029	0.852	1	0.015	0.376	0	0.000	0.000	**5**	**0.833**	**0.012**	**0.382**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	3	0.039	1.737	1	0.014	0.542	6	0.089	3.093	8	0.117	3.407	1	0.015	0.376	6	0	2	**25**	**4**	**0**	**2**

Papers **without international collaborations** in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS Collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration):

Average FTE researchers per year = 61.58

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.017	0.409	0	0.000	0.000	**1**	**0.167**	**0.003**	**0.083**
Chapters in scientific monographs published abroad *(ABC)*	0	0.000	0.000	0	0.000	0.000	**0**	0.000	0.000	1	0.016	0.462	0	0.000	0.000	0	0.000	0.000	**1**	**0.167**	**0.003**	**0.083**
Chapters in scientific monographs published in Slovakia *(ABD)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	73	1.072	46.420	145	2.291	86.271	98	1.628	54.722	94	1.543	43.432	145	2.471	59.303	84	1.441	35.817	**639**	**106.500**	**1.729**	**53.255**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	23	0.338	14.626	26	0.411	15.469	11	0.183	6.142	20	0.328	9.241	15	0.256	6.135	9	0.154	3.838	**104**	**17.333**	**0.281**	**8.668**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	0	0.000	0.000	0	0.000	0.000	2	0.033	1.117	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**2**	**0.333**	**0.005**	**0.167**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0	0.000	0.000	1	0.016	0.595	0	0.000	0.000	2	0.033	0.924	0	0.000	0.000	0	0.000	0.000	**3**	**0.500**	**0.008**	**0.250**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	0	0.000	0.000	0	0.000	0.000	2	0.033	1.117	2	0.033	0.924	1	0.017	0.409	0	0.000	0.000	**5**	**0.833**	**0.014**	**0.417**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	3	0.044	1.908	1	0.016	0.595	6	0.100	3.350	8	0.131	3.696	1	0.017	0.409	6	0	3	**25**	**4**	**0**	**2**

Papers **from international collaborations** in large-scale scientific projects (ALICE Collaboration, ATLAS Collaboration) are listed separately below:

Average FTE researchers per year = 7.91

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Chapters in scientific monographs published abroad *(ABC)*	0	0.000	0.000	0	0.000	0.000	**0**	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Chapters in scientific monographs published in Slovakia *(ABD)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	165	19.366	#######	119	13.967	730.595	148	21.113	991.824	125	17.361	678.923	114	13.953	524.867	93	11.538	421.884	**764**	**127.333**	**16.091**	**701.649**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	**0**	**0.000**	**0.000**	**0.000**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0	0	**0**	**0**	**0**	**0**

2.2. Measures of research outputs (citations, etc.)

2.2.1. Table with citations per annum (without self-citations)

Citations of papers **with international collaborations** in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS Collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration):
Average FTE researchers per year = 69.50

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	3 524	45.99	4 025	56.06	4 624	68.79	4 404	64.65	4 697	70.26	4 128	62.21	**25 402**	**4 233.67**	**60.92**
Citations in SCOPUS (1.2, 2.2) if not listed above	41	0.54	74	1.03	97	1.44	79	1.16	97	1.45	93	1.40	**481**	**80.17**	**1.15**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0.00	0	0.00	2	0.03	0	0.00	0	0.00	1	0.02	**3**	**0.50**	**0.01**
Other citations (not listed above) (3.1, 4.1)	3	0.04	2	0.03	2	0.03	0	0.00	3	0.04	0	0.00	**10**	**1.67**	**0.02**
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**

Citations of papers **without international collaborations** in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS Collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration):
Average FTE researchers per year = 61.58

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	773	11.35	876	13.84	1 050	17.44	825	13.54	1 071	18.25	1 218	20.89	**5 813**	**968.83**	**15.73**
Citations in SCOPUS (1.2, 2.2) if not listed above	41	0.60	74	1.17	97	1.61	79	1.30	97	1.65	93	1.60	**481**	**80.17**	**1.30**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0.00	0	0.00	2	0.03	0	0.00	0	0.00	1	0.02	**3**	**0.50**	**0.01**
Other citations (not listed above) (3.1, 4.1)	2	0.03	2	0.03	2	0.03	0	0.00	3	0.05	0	0.00	**9**	**1.50**	**0.02**
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**

Citations of papers **from international collaborations** in large-scale scientific projects (ALICE Collaboration, ATLAS Collaboration) are listed separately below:

Average FTE researchers per year = 7.91

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	2 751	322.89	3 149	369.60	3 574	509.84	3 579	497.08	3 626	443.82	2 910	361.04	**19 589**	**3 264.83**	**412.57**
Citations in SCOPUS (1.2, 2.2) if not listed above	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**
Other citations (not listed above) (3.1, 4.1)	1	0.12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**1**	**0.17**	**0.02**
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

[1] SZABÓ, Pavol - SAMUELY, Peter - KAČMARČÍK, Jozef - KLEIN, T. - MARCUS, J. - FRUCHART, D. - MIRAGLIA, S. - MARCENAT, C. - JANSEN, A.G.M. Evidence for Two Superconducting Energy Gaps in MgB2 by Point-Contact Spectroscopy. In *Physical Review Letters*, 2001, vol. 87, no. 13, art. no. 137005. (2000: 6.462 - IF, karentované - CCC). (2001 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.87.137005
Citations: **65**

[2] BUSTARRET, E. - MARCENAT, C. - ACHATZ, P. - KAČMARČÍK, Jozef - LÉVY, F. - HUXLEY, A. - ORTÉGA, L. - BOURGEOIS, E. - BLASE, X. - DÉBARRE, D. - BOULMER, J. Superconductivity in doped cubic silicon. In *Nature*, 2006, vol. 444, no. 7118, p. 465-468. (2005: 29.273 - IF, Q1 - JCR, 10.333 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents, WOS, SCOPUS). ISSN 0028-0836.
https://doi.org/10.1038/nature05340
Citations: **61**

[3] MUSATOV, Andrey - ROBINSON, N.C. Susceptibility of mitochondrial electron-transport complexes to oxidative damage. Focus on cytochrome c oxidase. In *Free Radical Research*, 2012, vol. 46, no. 11, p. 1313-1326. (2011: 2.878 - IF, Q2 - JCR, 0.929 - SJR, Q1 - SJR, karentované - CCC). (2012 - Current Contents, WOS, SCOPUS). ISSN 1071-5762.
https://doi.org/10.3109/10715762.2012.717273
Citations: **60**

[4] SEDLÁK, Marián. Large-scale supramolecular structure in solutions of low molar mass compounds and mixtures of liquids: I. Light scattering characterization. In *Journal of Physical Chemistry B*, 2006, vol. 110, no. 9, p. 4329-4338. (2005: 4.033 - IF, Q1 - JCR, 2.335 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents, WOS, SCOPUS). ISSN 1520-6106.
https://doi.org/10.1021/jp0569335
Citations: **57**

[5] SIEMENSMEYER, K. - WULF, E. - MIKESKA, H.J. - FLACHBART, Karol - GABÁNI, Slavomír - MAŤAŠ, Slavomír - PRIPUTEN, Pavol - EFDOKIMOVA, A. - SHITSEVALOVA, N.Yu. Fractional Magnetization Plateaus and Magnetic Order in the Shastry-Sutherland Magnet TmB4. In *Physical Review Letters*, 2008, vol. 101, no. 17, art. no. 177201. (2007: 6.944 - IF, Q1 - JCR, 5.950 - SJR, Q1 - SJR, karentované - CCC). (2008 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.101.177201
Citations: **55**

[6] SEDLÁK, Marián - RAK, Dmytro. Large-Scale Inhomogeneities in Solutions of Low Molar Mass Compounds and Mixtures of Liquids: Supramolecular Structures or Nanobubbles? In *Journal of Physical Chemistry B*, 2013, vol. 117, no. 8, p. 2495-2504. (2012: 3.607 - IF, Q2 - JCR, 1.943 - SJR, Q1 - SJR, karentované - CCC). (2013 - Current Contents, WOS, SCOPUS). ISSN 1520-6106.
https://doi.org/10.1021/jp4002093
Citations: **54**

[7] KOVAĽ, V. - ŠKORVÁNEK, Ivan - REECE, M.J. - MITOSERIU, L. - YAN, H. Effect of dysprosium substitution on crystal structure and physical properties of multiferroic BiFeO3 ceramics. In *Journal of the European Ceramic Society*, 2014, vol. 34, no. 3, p. 641-651. (2013: 2.307 - IF, Q1 - JCR, 1.122 - SJR, Q1 - SJR, karentované - CCC). (2014 - Current Contents, WOS, SCOPUS). ISSN 0955-2219.
https://doi.org/10.1016/j.jeurceramsoc.2013.10.002

Citations: **46**

[8] LAUDA, M. - FÜZER, J. - KOLLÁR, P. - STREČKOVÁ, M. - BUREŠ, R. - KOVÁČ, Jozef - BAŤKOVÁ, Marianna - BAŤKO, Ivan. Magnetic properties and loss separation in FeSi/MnZnFe2O3 soft magnetic composites. In *Journal of Magnetism and Magnetic Materials*, 2016, vol. 411, p. 12-17. (2015: 2.357 - IF, Q2 - JCR, 0.730 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 0304-8853.
https://doi.org/10.1016/j.jmmm.2016.03.051
Citations: **45**

[9] BELLOVÁ, Andrea - BYSTRENOVÁ, E. - KONERACKÁ, Martina - KOPČANSKÝ, Peter - VALLE, F. - TOMAŠOVIČOVÁ, Natália - TIMKO, Milan - BÁGEĽOVÁ, Jaroslava - BISCARINI, F. - GAŽOVÁ, Zuzana. Effect of Fe3O4 magnetic nanoparticles on lysozyme amyloid aggregation. In *Nanotechnology*, 2010, vol. 21, no. 6, art. no. 065103. (2009: 3.137 - IF, Q2 - JCR, 1.809 - SJR, Q1 - SJR, karentované - CCC). (2010 - Current Contents, WOS, SCOPUS). ISSN 0957-4484. Dostupné na). (2010 - Current Contents, WOS, SCOPUS). ISSN 0957-4484.
https://doi.org/10.1088/0957-4484/21/6/065103
Citations: **44**

[10] KLEIN, T. - ACHATZ, P. - KAČMARČÍK, Jozef - MARCENAT, C. - GUSTAFSSON, F. - MARCUS, J. - BUSTARRET, E. - PERNOT, J. - OMNES, F. - SERNELIUS, Bo.E. - PERSSON, C. - FERREIRA DA SILVA, A. - CYTERMANN, C. Metal-insulator transition and superconductivity in boron-doped diamond. In *Physical Review B*. Condensed matter and materials physics, 2007, vol. 75, no. 6, art. no. 165313. (2006: 3.107 - IF, Q1 - JCR, 2.620 - SJR, Q1 - SJR, karentované - CCC). (2007 - Current Contents, WOS, SCOPUS). ISSN 1550-235X.
https://doi.org/10.1103/PhysRevB.75.165313
Citations: **43**

Large-scale collaborations:

ATLAS:
AAD, G. - ANTOŠ, Jaroslav - BRUNCKO, Dušan - FERENCEI, Jozef - KLADIVA, Eduard - SEMAN, Michal - STRÍŽENEC, Pavol. Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. In *Physics Letters B*, 2012, vol. 716, no. 1, p. 1-29. (2011: 3.955 - IF, Q1 - JCR, 3.028 - SJR, Q1 - SJR, karentované - CCC). (2012 - Current Contents, WOS, SCOPUS). ISSN 0370-2693.
https://doi.org/10.1016/j.physletb.2012.08.020
Citations: **2 186**

AAD, G. - ABBOTT, B. - ABDALLAH, J. - ABDINOV, O. - ABEN, R. - ANTOŠ, Jaroslav - BRUNCKO, Dušan - KLADIVA, Eduard - STRÍŽENEC, Pavol - URBÁN, Jozef. Combined Measurement of the Higgs Boson Mass in pp Collisions at root s=7 and 8 TeV with the ATLAS and CMS Experiments. In *Physical Review Letters*, 2015, vol. 114, no. 19, art. no. 191803. (2014: 7.512 - IF, Q1 - JCR, 5.232 - SJR, Q1 - SJR, karentované - CCC). (2015 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.114.191803
Citations: **408**

AAD, G. - BRUNCKO, Dušan - GAŽO, Emil - FERENCEI, Jozef - KLADIVA, Eduard - STRÍŽENEC, Pavol. The ATLAS Experiment at the CERN Large Hadron Collider. In *Journal of Instrumentation*, 2008, vol. 3, p. S08003. (2007: 0.216 - SJR, Q3 - SJR, karentované - CCC). (2008 - Current Contents, WOS, SCOPUS). ISSN 1748-0221.
https://doi.org/10.1088/1748-0221/3/08/S08003
Citations: **326**

ALICE:
ABELEV, B. - BÁN, Jaroslav - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - MUŠINSKÝ, Ján - ŠÁNDOR, Ladislav - VAĽA, Martin. Centrality dependence of pi, K, and p production in Pb-Pb collisions at root s(NN)=2.76 TeV. In *Physical Review C*. Nuclear physics, 2013, vol. 88, no. 4, art. no. 044910. (2012: 3.715 - IF, 2.769 - SJR, Q1 - SJR, karentované - CCC). (2013 - Current Contents, WOS, SCOPUS). ISSN 2469-9985.
https://doi.org/10.1103/PhysRevC.88.044910
Citations: **153**

AAMODT, K. - BÁN, Jaroslav - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - PASTIRČÁK, Blahoslav - ŠÁNDOR, Ladislav - VAĽA, Martin. Higher Harmonic Anisotropic Flow Measurements of Charged Particles in Pb-Pb Collisions at root s(NN)=2.76 TeV. In *Physical Review Letters*, 2011, vol. 107, no. 3, art. no. 032301. (2010: 7.622 - IF, Q1 - JCR, 6.450 - SJR, Q1 - SJR, karentované - CCC). (2011 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.107.032301
Citations: **141**

AAMODT, K. - BÁN, Jaroslav - KRÁLIK, Ivan - KRIVDA, Marián - PASTIRČÁK, Blahoslav - ŠÁNDOR, Ladislav. The ALICE experiment at the CERN LHC. In *Journal of Instrumentation* [elektronický zdroj], 2008, vol. 3, art. no. S08002. (2007: 0.216 - SJR, Q3 - SJR, karentované - CCC). (2008 - Current Contents, WOS, SCOPUS). ISSN 1748-0221.
https://doi.org/10.1088/1748-0221/3/08/S08002
Citations: **131**

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

[1] SZABÓ, Pavol - SAMUELY, Peter - KAČMARČÍK, Jozef - KLEIN, T. - MARCUS, J. - FRUCHART, D. - MIRAGLIA, S. - MARCENAT, C. - JANSEN, A.G.M. Evidence for Two Superconducting Energy Gaps in MgB2 by Point-Contact Spectroscopy. In *Physical Review Letters*, 2001, vol. 87, no. 13, art. no. 137005. (2000: 6.462 - IF, karentované - CCC). (2001 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.87.137005
Citations: **449**

[2] KONERACKÁ, Martina - KOPČANSKÝ, Peter - ANTALÍK, Marián - TIMKO, Milan - RAMCHAND, C.N. - LOBO, D. - MEHTA, R.V. - UPADHYAY, R.V. Immobilization of proteins and enzymes to fine magnetic particles. In *Journal of Magnetism and Magnetic Materials*, 1999, vol. 201, no. 1-3, p. 427-430. (1998: 0.889 - IF, karentované - CCC). (1999 - Current Contents, WOS, SCOPUS). ISSN 0304-8853.
https://doi.org/10.1016/S0304-8853(99)00005-0
Citations: **170**

[3] BUSTARRET, E. - MARCENAT, C. - ACHATZ, P. - KAČMARČÍK, Jozef - LÉVY, F. - HUXLEY, A. - ORTÉGA, L. - BOURGEOIS, E. - BLASE, X. - DÉBARRE, D. - BOULMER, J. Superconductivity in doped cubic silicon. In *Nature*, 2006, vol. 444, no. 7118, p. 465-468. (2005: 29.273 - IF, Q1 - JCR, 10.333 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents, WOS, SCOPUS). ISSN 0028-0836.
https://doi.org/10.1038/nature05340
Citations: **167**

[4] SEDLÁK, Marián - AMIS, E.J. Dynamics of moderately concentrated salt-free polyelectrolyte solutions: Molecular weight dependence. In *Journal of Chemical Physics*, 1992, vol. 96, no. 1, p. 817-825. (1992 - Current Contents, WOS, SCOPUS). ISSN 0021-9606. https://doi.org/10.1063/1.462467
Citations: **147**

[5] BUSTARRET, E. - KAČMARČÍK, Jozef - MARCENAT, C. - GHEERAERT, E. - CYTERMANN, C. - MARCUS, J. - KLEIN, T. Dependence of the Superconducting Transition Temperature on the Doping Level in Single-Crystalline Diamond Films. In *Physical Review Letters*, 2004, vol. 93, no. 23, art. no. 237005. (2003: 7.035 - IF, karentované - CCC). (2004 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.93.237005
Citations: **141**

[6] BLAAUWGEERS, R. - BLAZKOVA, M. - ČLOVEČKO, Marcel - ELTSOV, V.B. - DE GRAAF, R. - HOSIO, J. - KRUSIUS, M. - SCHMORANZER, D - SCHOEPE, W. - SKRBEK, L. - SKYBA, Peter - SOLNTSEV, R.E. - ZMEEV, D.E. Quartz Tuning Fork: Thermometer, Pressure- and Viscometer for Helium Liquids. In *Journal of Low Temperature Physics*, 2007, vol. 146, no. 5-6, p. 537-562. (2006: 0.978 - IF, Q3 - JCR, 0.789 - SJR, Q1 - SJR, karentované - CCC). (2007 - Current Contents, WOS, SCOPUS). ISSN 0022-2291.
https://doi.org/10.1007/s10909-006-9279-4
Citations: **124**

[7] LYARD, L. - SAMUELY, Peter - SZABÓ, Pavol - KLEIN, T. - MARCENAT, C. - PAULIUS, L.M. - KIM, K.H.P. - JUNG, C.U. - LEE, H.S. - KANG, B.W. - CHOI, S. - LEE, S.I. - MARCUS, J. - BLANCHARD, S. - JANSEN, A.G.M. - WELP, U. - KARAPETROV, G. - KWOK, W.K. Anisotropy of the Upper Critical Field and Critical Current in Single Crystal MgB2. In *Physical Review B*. Condensed Matter, 2002, vol. 66, no. 18, art. no. R180502. (2001: 3.070 - IF, karentované - CCC). (2002 - Current Contents, WOS, SCOPUS). ISSN 1550-235X.
https://doi.org/10.1103/PhysRevB.66.180502
Citations: **124**

[8] SEDLÁK, Marián - AMIS, E.J. Concentration and molecular-weight regime diagram of salt-free polyelectrolyte solutions as studied by light-scattering. In *Journal of Chemical Physics*, 1992, vol. 96, no. 1, p. 826-834. (1992 - Current Contents, WOS, SCOPUS). ISSN 0021-9606.
https://doi.org/10.1063/1.462468
Citations: **119**

[9] SEDLÁK, Marián. Large-scale supramolecular structure in solutions of low molar mass compounds and mixtures of liquids: I. Light scattering characterization. In *Journal of Physical Chemistry B*, 2006, vol. 110, no. 9, p. 4329-4338. (2005: 4.033 - IF, Q1 - JCR, 2.335 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents, WOS, SCOPUS). ISSN 1520-6106.
https://doi.org/10.1021/jp0569335
Citations: **114**

[10] SEDLÁK, Marián. The ionic strength dependence of the structure and dynamics of polyelectrolyte solutions as seen by light scattering: The slow mode dilemma. In *Journal of Chemical Physics*, 1996, vol. 105, no. 22, p. 10123-10133. (1995: 3.610 - IF, karentované - CCC). (1996 - Current Contents, WOS, SCOPUS). ISSN 0021-9606.
https://doi.org/10.1063/1.472841
Citations: **111**

2.2.4. List of 10 most-cited publications published during the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

[1] LAUDA, M. - FÜZER, J.** - KOLLÁR, P. - STREČKOVÁ, M. - BUREŠ, R. - KOVÁČ, Jozef - BAŤKOVÁ, Marianna - BAŤKO, Ivan. Magnetic properties and loss separation in FeSi/MnZnFe2O3 soft magnetic composites. In *Journal of Magnetism and Magnetic Materials*, 2016, vol. 411, p. 12-17. (2015: 2.357 - IF, Q2 - JCR, 0.730 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 0304-8853.

https://doi.org/10.1016/j.jmmm.2016.03.051
Citations: **59**

[2] HLAWENKA, P. - SIEMENSMEYER, K. - WESCHKE, E. - VARYKHALOV, A. - SÁNCHEZ-BARRIGA, J. - SHITSEVALOVA, N.Yu. - DUKHNENKO, A.V. - FILIPOV, V.B. - GABÁNI, Slavomír - FLACHBART, Karol - RADER, O. - RIENKS, E.D.L.**. Samarium hexaboride is a trivial surface conductor. In *Nature Communications*, 2018, vol. 9, art. no. 517. (2017: 12.353 - IF, Q1 - JCR, 6.582 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents, WOS, SCOPUS). ISSN 2041-1723.
https://doi.org/10.1038/s41467-018-02908-7
Citations: **45**

[3] HAMULÁKOVÁ, S. - POPRAC, P. - JOMOVÁ, K. - BREZOVÁ, V. - LAURO, P. - DROSTINOVÁ, L. - JUN, D. - SEPSOVÁ, V. - HRABINOVÁ, M. - SOUKUP, O. - KRISTIÁN, P. - GAŽOVÁ, Zuzana - BEDNÁRIKOVÁ, Zuzana - KUČA, K. - VALKO, M.**. Targeting copper(II)-induced oxidative stress and the acetylcholinesterase system in Alzheimer's disease using multifunctional tacrine-coumarin hybrid molecules. In *Journal of Inorganic Biochemistry*, 2016, vol. 161, p. 52-62. (2015: 3.205 - IF, Q1 - JCR, 0.952 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 0162-0134.
https://doi.org/10.1016/j.jinorgbio.2016.05.001
Citations: **42**

[4] MICHON, B. - GIROD, C. - BADOUX, S. - KAČMARČÍK, Jozef - MA, Q. - DRAGOMIR, M. - DABKOWSKA, H.A. - GAULIN, B.D. - ZHOU, J.S. - PYON, S. - TAKAYMA, T. - TAKAGI, H. - VERRET, S. - MARCENAT, C. - TAILLEFER, L.** - KLEIN, T.**. Thermodynamic signatures of quantum criticality in cuprate superconductors. In *Nature*, 2019, vol. 567, no. 7747, p. 218-222. (2018: 43.070 - IF, Q1 - JCR, 16.345 - SJR, Q1 - SJR, karentované - CCC). (2019 - Current Contents, WOS, SCOPUS). ISSN 0028-0836.
https://doi.org/10.1038/s41586-019-0932-x
Citations: **40**

[5] MUSATOV, Andrey - SEDLÁK, E.**. Role of cardiolipin in stability of integral membrane proteins. In *Biochimie*, 2017, vol. 142, p. 102-111. (2016: 3.112 - IF, Q2 - JCR, 1.493 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents, WOS, SCOPUS). ISSN 0300-9084.
https://doi.org/10.1016/j.biochi.2017.08.013
Citations: **37**

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Citations: **34**

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https://doi.org/10.1016/j.jmmm.2018.11.026
Citations: **30**

[8] BEDNÁRIKOVÁ, Zuzana - HUY, P.D.Q. - MOCANU, M.-M. - FEDUNOVÁ, Diana - LI, M. Suan** - GAŽOVÁ, Zuzana**. Fullerenol C-60(OH)(16) prevents amyloid fibrillization of A beta(40) - in vitro and in silico approach. In *Physical Chemistry Chemical Physics*, 2016, vol. 18, no. 28, p. 18855-18867. (2015: 4.449 - IF, Q1 - JCR, 1.725 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 1463-9076.
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https://doi.org/10.1016/j.jallcom.2016.11.171
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https://doi.org/10.1007/s10714-018-2374-4
Citations: **24**

Large-scale collaborations:

ATLAS:
AAD, G. - ABBOTT, B. - ABDALLAH, J. - ABDINOV, O. - ABELOOS, B. - ANTOŠ, Jaroslav - BRUNCKO, Dušan - KLADIVA, Eduard - STRÍŽENEC, Pavol. Measurements of the Higgs boson production and decay rates and constraints on its couplings from a combined ATLAS and CMS analysis of the LHC pp collision data at root s=7 and 8 TeV. In *Journal of High Energy Physics*, 2016, vol. 2016, no. 8, art. no. 045. (2015: 6.023 - IF, Q1 - JCR, 1.343 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 1029-8479.
https://doi.org/10.1007/JHEP08(2016)045
Citations: **305**

AABOUD, M. - AAD, G. - ABBOTT, B. - ABDINOV, O. - ABELOOS, B. - BRUNCKO, Dušan - SMIEŠKO, Juraj - STRÍŽENEC, Pavol - URBÁN, Jozef. Search for dark matter and other new phenomena in events with an energetic jet and large missing transverse momentum using the ATLAS detector. In *Journal of High Energy Physics*, 2018, no. 1, art. no. 126. (2017: 5.541 - IF, Q1 - JCR, 1.227 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents, WOS, SCOPUS). ISSN 1029-8479.
https://doi.org/10.1007/JHEP01(2018)126
Citations: **124**

AABOUD, M. - AAD, G. - ABBOTT, B. - ABDALLAH, J. - ABDINOV, O. - BRUNCKO, Dušan - KLADIVA, Eduard - STRÍŽENEC, Pavol - URBÁN, Jozef. Search for new phenomena in final states with an energetic jet and large missing transverse momentum in pp collisions at root s=13 TeV using the ATLAS detector. In *Physical Review D*, 2016, vol. 94, no. 3, art. no. 032005. (2015: 4.506 - IF, Q2 - JCR, 2.236 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 1550-7998.
https://doi.org/10.1103/PhysRevD.94.032005
Citations: **96**

ALICE:
ADAM, J. - ADAMOVÁ, D. - AGGARWAL, M.M. - AGLIERI RINELLA, G. - AGNELLO, M. - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - MUŠINSKÝ, Ján - VAĽA, Martin. Enhanced production of multi-strange hadrons in high-multiplicity proton–proton collisions. In

Nature Physics, 2017, vol. 13, no. 6, p. 535-539. (2016: 22.806 - IF, Q1 - JCR, 13.412 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 1745-2473.
https://doi.org/10.1038/NPHYS4111
Citations: **84**

ADAM, J. - ADAMOVÁ, D. - AGGARWAL, M.M. - AGLIERI RINELLA, G. - AGNELLO, M. - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - MUŠINSKÝ, Ján - ŠÁNDOR, Ladislav - VAĽA, Martin. Correlated Event-by-Event Fluctuations of Flow Harmonics in Pb-Pb Collisions at root s(NN)=2.76 TeV. In *Physical Review Letters*, 2016, vol. 117, no. 18, art. no. 182301. (2015: 7.645 - IF, Q1 - JCR, 4.656 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 0031-9007.
https://doi.org/10.1103/PhysRevLett.117.182301
Citations: **63**

ADAM, J. - ADAMOVÁ, D. - AGGARWAL, M.M. - AGLIERI RINELLA, G. - AGNELLO, M. - KALIŇÁK, Peter - KRÁLIK, Ivan - KRIVDA, Marián - MUŠINSKÝ, Ján - ŠÁNDOR, Ladislav - VAĽA, Martin. Direct photon production in Pb–Pb collisions at root s(NN)=2.76 TeV. In *Physics Letters B*, 2016, vol. 754, p. 235-248. (: 4.787 - IF, Q1 - JCR, 3.320 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 0370-2693.
https://doi.org/10.1016/j.physletb.2016.01.020
Citations: **63**

2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute

PETER KOPČANSKÝ
Citations: **1 123**

MILAN TIMKO
Citations: **884**

ZUZANA GAŽOVÁ
Citations: **679**

MARTINA KONERACKÁ
Citations: **677**

JOZEF KOVÁČ
Citations: **575**

KAREL KUDELA
Citations: **483**

VLASTA ZÁVIŠOVÁ
Citations: **477**

Large-scale collaborations:

DUŠAN BRUNCKO (ATLAS CERN)
Citations: **15 172**

IVAN KRÁLIK (ALICE CERN)
Citations: **4 418**

2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute

PETER KOPČANSKÝ
Citations: **1 840**

MILAN TIMKO
Citations: **1 584**

PETER SAMUELY
Citations: **1 538**

KAREL KUDELA
Citations: **1 506**

PAVOL SZABÓ
Citations: **1 414**

JOZEF KAČMARČÍK
Citations: **1 341**

MARTINA KONERACKÁ
Citations: **1 324**

Large-scale collaborations:

DUŠAN BRUNCKO
Citations: **76 877**

IVAN KRÁLIK
Citations: **21 950**

2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute

PETER KOPČANSKÝ
Citations: **386**

ZUZANA GAŽOVÁ
Citations: **226**

MILAN TIMKO
Citations: **203**

VLASTA ZÁVIŠOVÁ
Citations: **193**

MICHAL RAJŇÁK
Citations: **190**

ZUZANA BEDNÁRIKOVÁ
Citations: **171**

JOZEF KAČMARČÍK
Citations: **170**

Large-scale collaborations:

DUŠAN BRUNCKO
Citations: **6 619**

IVAN KRÁLIK
Citations: **1 608**

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

- **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 for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on

CERN, Geneva, Switzerland. The participation of Slovakia in the scientific programme of CERN has support at governmental level. The participation of IEP SAS in the CERN experimental programme has been a backbone of the research in the high energy and particle physics for about 30 years. The Department of Subnuclear Physics has these activities covered by projects funded by Ministry of Education, Science, Research and Sport: **ATLAS** experiment on LHC in CERN: Deep-inelastic events and new physics at TeV energies and **ALICE** experiment at the CERN LHC: The study of strongly interacting matter under extreme conditions.

JINR Dubna, Russian Federation. The Department of Theoretical Physics has active collaboration with the Laboratory of Theoretical Physics JINR focused on applications of the quantum field theory in stochastic dynamics. Department of Subnuclear Physics maintained active contacts with the experiments STRELA (for studying charge-exchange processes in deuteron-proton collisions at energies above 1 GeV/c) and ALPOM2 (for measuring polarization effects with polarized deuteron beams at energies above 1 GeV/c at the Nuclotron complex, JINR).

Department of Space Physics has been involved in the development and construction of: i) The ESS service system on board the **ESA Rossetta** spacecraft at Comet 67P/Churyumov-Gerasimenko (in collaboration with the Space Technology Ireland at National University of Ireland, Maynooth (STIL-NUIM)), which allows communication between the spacecraft's main body, the orbiter and the Philae landing module; ii) The NUADU (NeUtral Atom Detection Unit) experiment, installed on board the **Double Star** TC-2 satellite (a joint ESA-CNSA project), to visualize the distribution of energy ions in the Earth's magnetosphere (in collaboration with Space Technology Ireland at National University of Ireland, Maynooth (STIL-NUIM)); iii) A detector for the study of electrons PEEL (Detector of Precipitating Energetic Electrons at high Latitude) in cooperation with the Democritus University of Thrace, Xanthi, Greece, within the **HotPay-2 mission** (Andoya Rocket Range project and Arctic Lidar Observatory ALOMAR); iv) MEP (Monitor of Energetic Particles) facilities for the **RadioAstron space mission** in cooperation with the Democrat University in Greece and the Institute of Space Research in Russia (IKI-RAN).

Department of Space Physics is working in the framework of international colaboration on the **JEM-EUSO telescope** (Joint Experiment Missions for the Extreme Universe Space Observatory). The telescope will focus on ultraviolet radiation generated by the interaction of ultra-high energy cosmic ray particles with the Earth's atmosphere. Participation also consisted of contributions to **NASA missions** (expertise for EUSO-SPB1 and POEMMA missions, development of detectors for EUSO-SPB2).
Centre of Low Temperature Physics performs research in close collaboration with many major centres of condensed matter physics in the framework of several European projects (H2020, COST, ERANET, mobility projects of GHMFL). CLTP belongs to 8 core founding

partners of **H2020 project European Microkelvin Platform (EMP)** providing open access to its infrastructure, developing new technologies and performing joint research activities. During the accreditation period the international selection panel accepted 8 experimental user project proposals for realization at CLTP. Participation in these user-projects boosted development of unique experimental methods (see Chapt. 2.8.3) and opened new collaborations in the field of quantum technologies and materials (see Chapt. 4). The support of EMP project has been acknowledged in several high-level scientific papers (1x Science Advances, 1x Physical Review Letters, 1 x Applied Physics Letters, 1x Scientific Reports, 4 x Physical Review B, etc.). **Peter Skyba**, as a work package leader of EMP, published 3 papers in highly impacted journals in the framework of this project and received the award **Scientists of the year 2019 in Slovakia** for research published in those articles.
The Cryocourse 2019 for young European scientists and one online international conference have been organized within the framework of this project in Slovakia. Cryocourse is the European intensive training course on cryophysics and cryogenic techniques. Having 20 years old tradition (since 2002), the Cryocourses are aiming to provide lectures and hands-on classes in the area of low temperature science and technology, and offer an excellent base for the education and transfer of knowledge in the field of cryogenics and low temperature techniques to scientific community, thus forming a pool of specialists for the laboratories working in field of the quantum technologies, cryogenic industry, etc. These courses are open to PhD students, post-docs, young technicians and engineers **from all European laboratories** with an interest in cryogenics, from about a Kelvin down millikelvin and below. Within reported period we organized the Cryocourse 2019, in September 8-19 in Michalovce & Košice, Slovakia. Altogether 44 participants from across Europe were trained on low and ultra-low temperature physics, cryogenics, experimental measurement techniques and engineering for quantum technology. We have been participaning on Cryocourses organization for more than 12 years.

In the frame of of COST-CA16218 project **„Nanoscale coherent hybrid devices for superconducting quantum technologies“ (NANOCOHYBRID)** a mobility network of European laboratories working in the field of superconductivity and superconducting nanostructures was created. The purpose of this Virtual Institute is to improve the availability of EU infrastructure and knowledge and focus on support of young researchers. Several scientific papers have been published thanks to the support of this project (1 x Science Advances, 1 x Advance Functional Materials, 2 x Physical Review B, etc). The project meeting in 2021 with international participation has been organized by CLTP researchers in Slovakia.

Grenoble High Magnetic Field Laboratory mobility projects. CLTP has a long-time collaboration with GHMFL. Several magnet time projects for the study of high magnetic field properties of high temperature superconductors have been realized in collaboration with CEA and CNRS in Grenoble. The results obtained during the accreditation period were published in 4 papers (1 x Nature, 2 x Physical Review Letters, 1 x Physical Review B).

Long-term research of magnetic and superconducting properties of high-quality single crystalline **rare earth borides** produced in IPMS Kiev (Ukraine) and NIMS Tsukuba (Japan) brought again top results in the accreditation period 2016-2021 by studying the topological Kondo insulator SmB_6 and quantum magnets (e.g. TmB_4 or HoB_{12}) within the frame of the projects APVV 14-0605, APVV 17-0020, VEGA 2/0032/16, 3 x DAAD. Thanks to the collaboration with HZB Berlin (Germany), the study of SmB_6 surface states was performed using ARPES as well as UHV STM, and thanks to cooperation with Hyogo University (Japan) the research of the influence of high pressure on Sm-valence and in-gap states was also realized in this unconventional insulator. The results are top publications (Nature Communications, Advanced Materials, Physical Review B Rapid, Philosophical Magazine). In cooperation with GPI Moscow and JINR Dubna, the dynamic charge stripes and crystal field excitation spectra were discovered in magnetic and superconducting *fcc* rare earth dodecaborides (5 x Physical Review B).

In the frame of JRP SAS-TUBITAK project **„Novel soft magnetic cores tailored for use in space qualified magnetometers and satellite devices“** (**MAGSAT)** we have developed improved fluxgate-type sensors designed for space applications (collaboration with Turkish partners). Our main attention was devoted to optimization of composition and thermal processing of soft magnetic cores in order to ensure the sufficient stability of the sensor and noise characteristics in temperature interval from -50°C to 85°C, which corresponds to operational range of low-orbit and middle-orbit satellites. The best stability of sensor characteristics was obtained for nanocrystalline FINEMET alloy where the sensitivity error coming from the temperature changes between −50 °C and +85 °C can be minimized down to 0.8 %. The obtained results clearly indicate that nanocrystalline FINEMET alloys belong to highly promising soft magnetic materials for applications in space-qualified magnetometers [https://doi.org/10.1109/JSEN.2020.3024547].

A new original bottom-up approach to the **preparation of polymeric nanoparticles** was elaborated. This approach requires homopolymers (not copolymers) of only one type for the nanoparticle preparation, and without the need for any additives. The method is based on controlled self-assembly of thermoresponsive homopolymers of the poly(alkylacrylic acid) type by changing temperature near the critical point. Mechanisms leading to stable nanoparticles were described at the molecular level. Prevention of macroscopic phase separation as a competitive process is realized via a high surface zeta potential of the seed nuclei starting the phase separation and via an entropic gain of counterions in the system. Particle stability (process irreversibility) is achieved by hydrogen bonds, especially of the COOH ..... COO - type between protonated and ionized carboxyl groups. Our work also includes analysis of the influence of other effects such as Rayleigh instability of charged polymer chains and their aggregates, concentration and conformation-dependent condensation of counterions, comparison with analogous systems of neutral polymers, and methods of decomposition (disintegration) of nanoparticles. The international relevance of this research is documented by publication in a highly ranked prestigious journal [https://doi.org/10.1016/j.cis.2015.12.005].

Our young investigator, Dr. Dmytro Rak took part in a collaborative research conducted by young investigators from several countries under supervision of prof. Alejandro Sosnik from **Technion-Israel Institute of Technology**, Haifa, Israel, within the frame of the 7th Framework Programme-European Commission Marie Curie European Grant with acronym NANOTAR (**Self-assembly polymeric nano-biomaterials for drug delivery and targeting**). This research was focused on self-assembly of various polymers and polymer architectures that were selected as promising candidates for polymeric drug carriers for targeted drug delivery, namely poly(vinyl alcohol)-graft-poly-(methyl methacrylate) [https://doi.org/10.1016/j.jcis.2019.06.047] and chitosan-poly(methyl methacrylate) graft copolymer [https://doi.org/10.1016/j.carbpol.2019.02.022].

The resear group Protein amyloid strucrures participated in the **COST project „Non-globular proteins – from sequence to structure, function and application in molecular physiopathology“ (NGP-NET)** provided a platform for common research with leading laboratories from 28 countries studying the mechanisms of amyloid aggregation of native unfolded and tandem-repeat proteins. The collaboration resulted in better understanding of the biophical principles underlying protein self-assembly and proposed an ontological roadmap of amyloid aggregation considering the fundamental concepts of physico-chemical equilibrium [https://doi.org/10.3389/fnmol.2020.582488]. To establish necessary standard protocols for amyloid aggregation studies, the set of minimum information required for the reproducible of aggregation experiments (MIRAggE) was created. This handbook aims to help researchers reproduce published results, facilitate systematic data storage in databases, and design new studies. Thanks to the collaboration, the project under H2020 call was submitted allowing continuation of our common research. The project meeting in 2017 has been organized by research group in Košice with the participation of 90 experts in protein structure and self-assembly from 28 countries.
International collaboration helps to identifiy the effective inhibitors of amyloid aggregation of proteins with partners from **National Taiwan University** and **East China University**

(Shanghai) in the frame of the projects JRP SAS-MOST „Effect of small molecules and nanoparticles on amyloid aggregtion of poly/peptides (2016 – 2018, Z. Gažová – W) and two APVV projects (APVV SK-CN-2015-0023, 2016 - 2017; APVV SK-CN-2017-0033, 2018 – 2019, Z. Gažová – W) dealing with the discovery and mechanism of the extracts from traditional Chinese herbs in treatment of Alzheimer´s disease.

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

[1] **Metallography'16**, 16th International Symposium „Metallography and Fractography 2016“, Stará Lesná, Slovakia, 200 participants, 20.-22.4.2016

[2] **CSMAG'16**, Czech and Slovak Conference on Magnetism, Košice, Slovakia, 320 participants, 13.-17.6.2016

[3] **QFS 2016**, Quantum Fluids and Solids, Prague, Czech Republic, 221 participants, 10.-16.8.2016

[4] **ISMD 2016**, 46th International Symposium on Multiparticle Dynamics, Jeju Island, South Korea, 29.8.-2.9.2016

[5] **XXXVI Physics in Collision**, Quy Nhon, Vietnam, ~ 50 participants, 3.-18.9.2016

[6] **STM 2016**, Small Triangle Meeting, Ptíčie, Slovakia, 30 participants, 16.-19.10.2016

[7] **CHAOS 2017**, 10th International Conference on Chaotic Modeling, Simulation and Applications, Barcelona, Spain, 30.5.-2.6.2017

[8] **MMCP 2017**, The International Conference “Mathematical Modeling and Computational Physics, Dubna, Russia, 3.-7.7.2017

[9] **3rd NGP-NET SYMPOSIUM ON NON-GLOBULAR PROTEINS,** Košice, Slovakia, ~ 90 participants, 28.8.-1.9.2017

[10] **SSB 2017**, 10th International Conference Structure and Stability of Biomacromolecules, Košice, Slovakia, ~ 60 participants, 4.-7.9.2017

[11] **XXXVII Physics in Collision**, Prague, Czech Republic, 4.-8.9. 2017

[12] **KČSF 2017**, 19th Conference of Czech and Slovak Physicists, Prešov, Slovakia, ~ 100 participants, 4.-7.9.2017

[13] **ISMD 2017**, 47th International Symposium on Multiparticle Dynamics, Tlaxcala City, Mexico, 11.- 15.9.2017

[14] **ATLAS Overview Week 2017**, Bratislava, Slovakia, ~ 300 participants, 9.-13.10.2017

[15] **STM 2017**, Small Triangle Meeting, Medzilaborce, Slovakia, ~ 40 participants, 15.-18.10.2017

[16] **International Conference on biological application of nanoparticles,** Chennai, India, 225 participants, 4.-5.12.2017

[17] **RECFA Bratislava**, Regional European Committee for Future Accelerators Meeting, Bratislava, Slovakia, 18.-19.5.2018

[18] **ECIS 2018**, European Colloid and Interface Society Symposium, Ljubljana, Slovenia, 515 participants, 3.-7.9.2018

[19] **ISMD 2018**, 48th International Symposium on Multiparticle Dynamics, Singapore, Singapore, 3.-7.9.2018

[20] **STM 2018**, Small Triangle Meeting, Ptíčie, Slovakia, ~ 40 participants, 7.-10.10.2018

[21] **Recent Advancements in Nanoscience and Technology**, Chennai, India, 150 participants, 7.12.2018

[22] **Metallography'19**, 17th International Symposium “Metallography and Fractography 2019“, Nový Smokovec, Slovakia, 120 participants, 24.-26.4.2019

[23] **CSMAG'19**, Czech and Slovak Conference on Magnetism, Košice, Slovakia, 300 participants, 3.-7.6.2019

[24] **Workshop on Quantum Magnetism: Theoretical Challenges and Future Perspectives**, Košice, Slovakia, 25 participants, 7.-8.6.2019

[25] **Machine Learning, Parallel and Hybrid Computations and Big Data Analytics**, Stará Lesná, Slovakia, 26 participants, 1.-4.7.2019

[26] **MMCP 2019**, The International Conference “Mathematical Modeling and Computational Physics“, Stará Lesná, Slovakia, 104 participants, 1.-5.7.2019

[27] **PASREG 2019**, 11th International Workshop on Processing and Applications of Superconducting Bulk Materials, Prague, Czech Republic, 81 participants, 29.-30.8.2019

[28] **SSB 2019**, 11th International Conference "Structure and stability of Biomacromolecules", Košice, Slovakica, 72 participants, 3.-6.9.2019

[29] **Cryocourse 2019**, International advanced school on low and ultra-low temperature physics, cryogenics, experimental measurement techniques and engineering for quantum technology, Zemplínska šírava and Košice, Slovakia, 50 participants, 8.-19.9.2019 Cryocourses - European Microkelvin Platform

[30] **STM 2019**, Small Triangle Meeting, Spišské Tomášovce, Slovakia, 39 participants, 6.-9.10.2019

[31] **M-ERA.NET "TESTIMONIES" workshop**, Košice, Slovakia, 15 participants, 5.-6.3.2020

[32] **BIONANOSMART**, The International Conference on Nanoscience and Technology, Stará Lesná, Slovakia, 50 participants, 10.-14.3.2020

[33] **KČSF 2020**, 20th Conference of Czech and Slovak Physicists, FMP UK Prague, Czech Republic, 80 participants, 7.-10.9.2020

[34] **STM 2020**, Small Triangle Meeting, Spišské Tomášovce, Slovakia, 40 participants, 7.-10.10.2020

[35] **EMP – evaluation user meeting** (on-line), 78 participants, 29.3.2021

[36] **International Conference on Precision Physics and Fundamental Physical Constants 2021**, Stará Lesná, Slovakia, 80 participants, 24.-28.5.2021

[37] **Superconducting Hybrids @ Extreme**, Štrbské Pleso, Slovakia, 80 participants, 28.6.-2.7.2021

[38] **STM 2021**, Small Triangle Meeting, Slovenský raj, Slovakia, 50 participants, 18.-22.10.2021

2.3.3. List of edited proceedings from international scientific conferences

Proceedings of the 16th Czech and Slovak Conference on Magnetism, 13.-17.6.2016, Košice, Slovakia
Editors: J. Kováč and R. Varga
Acta Physica Polonica A, Vol. 131, No. 4, July 2016, pp. 615-1191

Proceedings of the Quantum Fluids and Solids Conference, 10.-16.8.2016, Prague, Czech Republic
Editors: L. Skrbek and P. Skyba
Journal of Low Temperature Physics, Vol. 187, No. 5-6, June 2017, pp. 331-776

Proceedings of the 18th Small Triangle Meeting on Theoretical Physics, 16.-19.10., 2016, Ptíčie, Slovakia
Editors: J. Buša, M. Hnatič, P. Kopčanský
© Institute of Experimental Physics, Slovak Academy of Sciences, 2017, 225 p.
ISBN 978-80-8143-203-3

Proceedings of the 19th Conference of Czech and Slovak Physicists, 4.-7.9.2017, Prešov University, Prešov, Slovakia
Editors: A. Džubinská, M. Reiffers, Bratislava, Slovak Physical Society, 2017, 128 p.
ISBN 978-80-89855-04-9

Book of Contributions, 10th International Conference Structure and Stability of Biomacromolecules SSB2017, 4-7.9.2017, Košice, Slovakia
Editors: V. Lysáková, D. Fedunová, Z. Bednáriková, M. Nikorovič, M. Gančár, K. Uličná, K. Šipošová © Institute of Experimental Physics, Slovak Academy of Sciences, 2017, 147 p.
ISBN 978-80-89656-19-6

Proceedings of the 19th Small Triangle Meeting on Theoretical Physics, 15.-18.10., 2017, Medzilaborce, Slovakia
Editors: J. Buša, M. Hnatič, P. Kopčanský
© Institute of Experimental Physics, Slovak Academy of Sciences, 2018, 176 p.
ISBN 978-80-8143-233-0

Book of Contributions, 11th International Conference Structure and Stability of Biomacromolecules SSB2019, 3.-6.9.2019, Košice, Slovakia
Editors: D. Fedunová, Z. Bednáriková, V. Vaník
© Institute of Experimental Physics, Slovak Academy of Sciences, 2019
ISBN: 978-80-89656-25-7

Proceedings of the 20th Small Triangle Meeting on Theoretical Physics, 7.-10.10., 2018, Príčie, Slovakia
Editors: J. Buša, M. Hnatič, P. Kopčanský
© Institute of Experimental Physics, Slovak Academy of Sciences, 2019, 229 p.
ISBN 978-80-8143-253-8

Proceedings of the 17th Czech and Slovak Conference on Magnetism, 3.-7.6.2019, Košice, Slovakia
Editors: J. Kováč and R. Varga
Acta Physica Polonica A, Vol. 137, No. 5, May 2020, pp. 589-1012

Proceedings of the 21th Small Triangle Meeting on Theoretical Physics, 6.-9.10., 2019, Spišské Tomášovce, Slovakia
Editors: J. Buša, M. Hnatič, P. Kopčanský
© Institute of Experimental Physics, Slovak Academy of Sciences, 2020, 160 p.
ISBN 978-80-8143-280-4

Proceedings of the 20th Conference of Czech and Slovak Physicists, 7.-10.9.2020, Prague, Czech Republic
Editors: A. Džubinská, M. Reiffers
EQUILIBRIA, s.r.o. Košice, Slovak Physical Society, Czech Physical Society, 2020, 188 p.
ISBN 978-80-89855-13-1

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

- **National position of the institute**

2.3.5. List of selected activities of national importance

Cooperation of the Slovak republic and **CERN** takes place not only on scientific level, but implies also strong diplomatic and industrial ties. Slovak industrial subjects may participate in all CERN tenders and technological know-how may flow back from CERN to Slovakia. These facts stress the importance of the IEP SAS participation in the major CERN projects like **ALICE** and **ATLAS**.

The research teams from IEP SAS and **Faculty of Sciences, Pavol Jozef Safarik University in Košice** cooperated during the **COVID-19** pandemic when they participated in preparation of magnetic nanoparticles as part of the **"10,000 tests per day" initiative**. At the beginning of the quarantine, colleagues from the initiative "10,000 tests per day" addressed us that they are developing a Slovak analogy of their tests - rapid tests for SARS-CoV-2 detection based on RT-PCR and due to emergency and quarantine measures need magnetic nanoparticles (MNPs) coated with silica with the required properties. Although we have not yet dealt with the field of virus detection and DNA / RNA separation using magnetic nanoparticles, naturally, to help and actively contribute to solving the pandemic, we have responded positively. Also, based on these experiments, we obtained experience and information about the limits of standardly used systems and got an idea of how to improve them.

During the early stage of **COVID-19** pandemic the access to big computer resources was needed for fast simulations of the virus molecules. **Worldwide LHC Computing Grid** (WLCG) as global infrastructure for high energy computation, part of which is also computing farm at our institute, has very quickly managed the possibility to run such simulations on the resources connected. During few months more than half of computing resources on our farm were working for such jobs. This was our contribution to faster reaction on the virus worldwide.

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

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

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

International	2016	2017	2018	2019	2020	2021	2016-2021
Orals and posters	117	125	45	84	12	37	420
Invited talks	22	21	22	18	14	16	113

Invited talks:

2016:

[1] P. Kopčanský et al., Magnetically anisotropic composite systems, 45th WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2016, 27.2.-2.3.2016, Szczyrk, Poland

[2] M. Timko et al., Hyperthermic effect in mechanically treated magnetosomes, 45th WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2016, 27.2.-2.3.2016, Szczyrk, Poland

[3] P. Samuely et al., Interplay of CDW and superconducting orders in copper vdoped TiSe2 single crystals, Probing Superconductivity at the Nanoscale: New advances, saas-Fee, COST MP-1201 NanoSC Workshop, 12.-15.4.2016, Switzerland

[4] P. Szabó et al., STM studies of the superconductor-insulator transition in MoC ultrathin films, Probing Superconductivity at the Nanoscale: New advances, saas-Fee, COST MP-1201 NanoSC Workshop, 12.-15.4.2016, Switzerland

[5] P. Diko et al., Microstructure of Heuser allys prepared by mould casting and melt spinning, Metallography´16: 16th international symposium on metallography and materials science, 20.- 22.4.2016, Stará Lesná, High Tatra Mountains, Slovakia

[6] Z. Pribulová et al., Competing orders of CDW superconductivity in copper doped TiSe2. STM, AC calorimetry and Hall-probe magnetometry studies, 5th International Conference on Superconductivity and Magnetism, 24.-30.4.2016, Fethiye, Turkey

[7] P. Szabó et al., Scanning tunneling spectroscopy of SrPd2Ge2 single crystal, isostructural with 122 iron pnictides, IBS 2016: International workshop Advances in preparation and investigation of emergent iron-based superconductors, 23.-25.5.2016, Dresden, Germany

[8] P. Samuely et al., Interplay of charge density waves and superconductivity in copper doped TiSe2, IBS 2016: International workshop Advances in preparation and investigation of emergent iron-based superconductors, 23.-25.5.2016, Dresden, Germany

[9] P. Kopčanský et al., Magnetic fluids and their complex systems, PHYSICS OF LIQUID MATTER: MODERN PROBLEMS (PLMMP-2016), 27.-30.5.2016, Kiiv, Ukraine

[10] M. Timko et al., Physical properties of bacterially synthesized magnetic nanoparticles, PHYSICS OF LIQUID MATTER: MODERN PROBLEMS (PLMMP-2016), 27.-30.5.2016, Kiiv, Ukraine

[11] I. Škorvánek et al., Development of selected amorphous and nanocrystalline soft magnetic systems with enhanced functional properties, 16th Czech and Slovak Conference on Magnetism, 13.-17.6.2016, Košice, Slovakia

[12] P. Kopčanský et al., Ferronematics- the way to magnetovision camera, 10th PAMIR International Conference Fundamental and Applied MHD PAMIR 2016, Cagliari, 20.-24.6.2016, Sardinia, Italy

[13] M. Timko et al., Dielectric relaxations in a transformer oil-based magnetic fluid, 10th PAMIR International Conference Fundamental and Applied MHD PAMIR 2016, 20.-24.6.2016, Cagliari, Sardinia, Italy

[14] P. Samuely et al., Interplay between superconductivity and charge density waves in CuxTiSe2, SUPERSTRIPES 2016: Quantum in Complex Matter: Superconductivity, Magnetism, Ferroelectricity, 23.-29.6.2016, Ischia, Italy

[15] P. Szabó et al., STM studies of the superconductor-insulator transition in MoC ultrathinthin films, SUPERSTRIPES 2016: Quantum in Complex Matter: Superconductivity, Magnetism, Ferroelectricity, 23.-29.6.2016, Ischia, Italy

[16] P. Kopčanský et al., Ferronematics – Way To Liquid Crystalline Sensor of Magnetic Field, 14th International Conference on Magnetic Fluids, 4.-8.7. 2016, Ekaterinburg, Rusko

[17] M. Timko et al., Structure and Hyperthermia Characterization of the Magnetosomes Solutions, 14th International Conference on Magnetic Fluids, 4.-8.7. 2016, Ekaterinburg, Rusko

[18] P. Szabó et al., Szupravezetés erôsen rendezetlen rendszerekben. MoC vékonyrétegek szupravezetô-szigetelô átmenet közelében, Magyar Fizikus Vándorgyűlés 2016, 24.-27.8.2016, Szeged, Hungary

[19] P. Samuely et al., Influence of magnetic field on the Altshuler-Aronov effect in homogeneously disordered ultrathin superconducting MoC films, Nano confined superconductors and their application, COST MP-1201 Workshop, 3.-7.9.2016, Garmisch-Partenkirchen, Germany

[20] P. Kopčanský et al., Liquid crystal doped by magnetic fluids, XI Conference on Liquid Crystals Chemistry, Physics and Applications CLC'2016, 18.-23.9.2016, Krynica-Zdrój, Poland

[21] I. Škorvánek et al., Advanced Nanocrystalline Magnetic Materials for Energy and Sensor Applications, NANOCON 2016: 8th International Conference on Nanomaterials - Research and Application, 19.-21.10.2016, Brno, Czech Republic

[22] P. Diko et al., Microstructure of IS YBCO Bulk Superconductors, Symposium on Materials for Energy and Environment Sustainability, Shibaura Institute of Technology, 16.12.2016, Tokyo, Japan

2017:

[1] P. Kopčanský et al., Physico-chemical Characterisation of Magnetoferritin and its Potential Bio-Applications, 46th Winter School on Wawe and Quantum Acoustics XLVth Jubilee Winter School on Environmental Acoustics and Vibraacoustics. Archives of Acoustics, 2017, 27.2.-2.3.2017, Szczyrk, Poland

[2] M. Timko et al., Structure and Hyperthermia Characterization of Bacterially Synthesized Magnetic Nanoparticles, 46th Winter School on Wawe and Quantum Acoustics XLVth Jubilee Winter School on Environmental Acoustics and Vibraacoustics. Archives of Acoustics, 2017, 27.2.-2.3.2017, Szczyrk, Poland

[3] M. Hnatič, Field-theoretic models of developed turbulence and stochastic dynamics, XXIV International Seminar Nonlinear Phenomena in Complex Systems, Joint Institute for Power and Nuclear Research - Sosny, 16.-19.5.2016, Minsk, Belarus

[4] P. Kopčanský et al, Low magnetic field response of ferronematics, Moscow International Symposium on Magnetism, 1.-5.7.2017, Moscow, Faculty of Physics M.V. Lomonosov MSU, Russia

[5] P. Samuely et al., Dynes superconductors - gapless ultrathin superconducting film, Moscow International Symposium on Magnetism, Moscow International Symposium on Magnetism, 1.-5.7.2017, Moscow, Faculty of Physics M.V. Lomonosov MSU, Russia

[6] M. Timko et al., Magnetic fluids for power transformer applications, Moscow International Symposium on Magnetism, 1.-5.7.2017, Moscow, Faculty of Physics M.V. Lomonosov MSU, Russia

[7] I. Škorvánek et al., Rapidly quenched amorphous and nanocrystalline bilayers for sensor applications, 24th International Symposium on Metastable, Amorphous and Nanostructured Materials, 18.-23.6.2017, San Sebastián - Donostia, Spain

[8] I. Škorvánek et al., Structure-property relationship in rapidly quenched alloys correlated with melt precursor processing, LAM-16: 16th International Conference on Liquid and Amorphous Metals, 4.-9.9.2016, Bonn-Bad Godesberg, Germany

[9] Z. Bednáriková et al., Structure and Dynamics of β-amyloid Proto-fibrills as a Basis for Rational Drug Design against Alzheimer's Disease, Structure and Stability of Biomacromolecules Conference, 4.-7.9.2017, Košice, Slovakia

[10] E. Bystrenová et al., Amyloid Structures and Their Influence to Neurall Cells. Structure and Stability of Biomacromolecules Conference, 4.-7.9.2017, Košice, Slovakia

[11] J. Baláž, Rosetta mission - a year after grand finale, 19th Conference of Czech and Slovak physicists, 4.-7.9.2017, Prešov, Slovakia

[12] M. Timko et al., High magnetization and thermal stability of gama-FE2O3 nanoparticles, 19th Conference of Czech and Slovak physicists, 4.-7.9.2017, Prešov, Slovakia

[13] P. Skyba et al.,Mechanical resonators in physical vacuum of topological superfluids,19th Conference of Czech and Slovak physicists, 4.-7.9.2017, Prešov, Slovakia

[14] I. Škorvánek et al., Soft magnetic nanocomposites for sensor applications, 19th Conference of Czech and Slovak physicists, 4.-7.9.2017, Prešov, Slovakia

[15] M. Hnatič, Quantum Field Theory Methods in Complex Classical Systems, The XXI International Scientific Conference of Young Scientists and Specialists (AYSS-2017), JINR, OMUS, 2.10.2017, Dubna, Russia

[16] V. Závišová et al., Interactions of iron oxide nanoparticles with human cells, an in vitro study, NANOCON 2017: 9th International conference on nanomaterials - research and application, 18.-20.10.2017, Brno, Czech Republic

[17] P. Kopčanský et al., Magnetic nanoparticles as an Anti-amyloidogenic Agent: Study of Nanoparticles-induced inhibition and destruction of amyloid structures, International Conference on Biological Applications of Nanoparticles, 4.-5.12.2017, Chennai, India

[18] M. Timko et al., Hyperthermia effect in iron oxides magnetic nanoparticles. In International Conference on Biological Applications of Nanoparticles, International Conference on Biological Applications of Nanoparticles, 4.-5.12.2017, Chennai, India

[19] M. Koneracká et al., Modified graphene oxide in biosensor application, ICAE 2017: The 4th International Conference on Advanced Electromaterials, 21.-24.11.2017, Jeju, Korea

[20] I. Škorvánek et al., Rapidly quenched amorphous and nanocrystalline bilayer ribbons with tailorable soft magnetic properties, 4th International Symposium on Advanced Magnetic Materials and Applications, 10.-13.12.2017, Phu Quoc, Vietnam

[21] P. Diko et al., Microstructural aspects of REBCO bulks with chemical pinning, 10th International Workshop on Processing and Application of Superconducting (RE)BCO Large Grain Materials, 11.-12.12.2017, Tokyo, Japan

2018:

[1] P. Kopčanský et al., Destruction of amyloid structures with the help of ultrasonics, hyperthermia and radiation treatments in the presence of magnetic nanoparticles. 14th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 47th Winter School on Wave and Quantum Acoustics. 26.02.-1.03.2018, Szczyrk, Poland

[2] M. Timko et al., New composites based on liquid crystals with superionic nanoparticles: development, preparation, dielectric and acoustic properties. 14th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 47th Winter School on Wave and Quantum Acoustics. 26.02.-1.03.2018, Szczyrk, Poland

[3] I. Škorvánek et al., Field-annealed amorphous and nanocrystalline ribbons and composites with improved energy performance. TMS 2018, 147-th Annual Meeting and Exhibition, 11.-15.3.2018, Phoenix, Arizona, USA

[4] P. Szabó et al., On the origin of the quasiparticle states in the superconducting gap of homogeneously disordered ultrathin films. MoC case. Coherent superconducting hybrids and related materials, 26.- 29.3.2018, Les Arcs 1800, France

[5] P. Samuely et al., Superconductivity in restricted geometries. The cases of CuxTiSe2, β-Bi2Pd & (LaSe)1.14(NbSe2). International Conference on Multi-Condensate Superconductivity and Superfluidity in Solids and Ultra-Cold Gasses, 14.-18.5.2018, Terst, Italy

[6] P. Kopčanský et al., Ferronematics-Liquid crystalline sensor of magnetic fields. Physics of Liquid Matter: Modern Problems (PLMMP 2018), 18.-22.5.2018, Kiev, Ukraine

[7] K. Šipošová et al., The Way To Fight With The Amyloid Protein Aggregates: Role Of Nanoparticles. Physics of Liquid Matter: Modern Problems (PLMMP 2018), 18.-22.5.2018, Kiev, Ukraine

[8] M. Timko et al., Hyperthermia effect in various iron oxides. Physics of Liquid Matter: Modern Problems (PLMMP 2018), 18.-22.5.2018, Kiev, Ukraine

[9] M. Molčan et al., Structure and hyperthernia effect in magnetosome solution. 11th Conference on Colloid Chemistry, 29.5.2018, Eger, Hungary

[10] I. Škorvánek et al., Development of new rapidly quenched bilayer ribbons with tunable soft magnetic properties. IcAUMS 2018, International Conference of Asian Union of Magnetic Societies, 3.-7.6.2018, Jeju, Korea

[11] J. Kováč et al., Testing and Comparison of models for fitting of magnetic hysteresis loops. The XIX International Scientific Conference New Technologies and Achievements in Metallurgy and Material Engineering and Production Engineering and Physics, 7.-8.6.2018, Czestochowa, Poland

[12] P. Samuely et al., Evidence of Ising Superconductivity in Misfit layer Compounds. Workshop Misfit Layer compound as Ising superconductor, 19.-20.6.2018, Nantes, France

[13] S. Pastirčák et al., Experiment Baikal and its computational and CORSIKA simulational needs. Workshop, Next generation CORSIKA Workshop, 25.-26.6.2018 at KIT

[14] I. Škorvánek et al., Rapidly quenched amorphous and nanocrystalline bilayer ribbons for magnetic sensors. International Conference on Processing and Manufacturing of Advanced Materials, THERMEC 2018, 8.- 13.7.2018, Paris, France

[15] I. Škorvánek et al., Soft magnetic nanocrystalline bilayer ribbons for sensor applications. Symposium of 30th Anniversary of Nano Crystalline Soft Magnetic Alloys, FINEMET 30, 29.-31.8.2018, Sendai, Japan

[16] D. Rak and M. Sedlák, Mesoscale solubility in liquid solutions and mixtures, ECIS (European Colloid and Interface Society) symposium 2018, 3.-7.9.2018, Ljubljana, Slovenia

[17] K. Flachbart et al., TmB4 – magneto-caloric effect and other properties, XVII. conference of Solid state and High pressure problems, 15.9.2018, Sochi, Russia

[18] Š. Mackowjak et al. (JEM EUSO collaboration), Atmospheric Monitoring for UHECR Space-based Missions, AtmoHEAD (ATmospheric MOnitoring for High Energy Astroparticle Detectors), 24.-26.9.2018, Anacapri, Italy

[19] I. Škorvánek et al., Amorphous and nanocrystalline bilayer composites with tailorable soft magnetic properties. The 9th International Workshop on Advanced Materials Science and Nanotechnology, IWAMSN 2018, 7.-11.11.2018, Ninh Binh, Vietnam

[20] Z. Gažová et al., Amyloid aggregation of poly/peptides. YABEC 2018, The 24-th Symposium of Young Asian Biological Engineers´ Community, 15.-.17.11.2018, Taipei, Taiwan

[21] P. Kopčanský et al., Magnetoferritin. International Conference on Biomedical Applications of Magnetic Nanoparticles, 7.12. 2018, Chennai, India

[22] M. Timko et al., Magneto-ultrasonic heating in iron oxides magnetic nanoparticles suspension. International Conference on Biomedical Applications of Magnetic Nanoparticles, 7.12. 2018, Chennai, India

2019:

[1] V. Závišová et al., Added value and impact of participating in a COST Action Examples of experience and best practice, COST INFODAY 2019, 7.2.2019, Bratislava, Slovakia

[2] Z. Vargaeštoková et al., MoGa, two gaps or not two gaps, that's a question, COST-Nanocohybri workshop, PROBING SUPERCONDUCTING HYBRIDES AT NANOSCALE, February 2019, 19.2.2019, Eilat, Israel

[3] P. Kopčanský et al., Ferronematics liquid crystalline materials for sensing of magnetic fields, 15th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 48th Winter School on Wave and Quantum Acoustics, 25.-28.2.2019, Szczyrk, Poland

[4] M. Timko et al., Magnetic field effect on thermal, dielectric and viscous properties of a transformer oil-based magnetic nanofluid, 15th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 48th Winter School on Wave and Quantum Acoustics, 25.-28.2.2019, Szczyrk, Poland

[5] I. Škorvánek et al., Soft magnetic Fe(Co)-based nanocrystalline alloys for applications at elevated temperatures, „TMS 2019, 148-th Annual Meeting and Exhibition“, 10.-14.3.2019, San Antonio, Texas, USA

[6] K. Šipošová et al., A comparative Study of the Effect of Non-ionic Detergents and Phospholipids on Insulin Amyloid Aggregation, Workshop on biophysics Graduate Institute of Applied Physics College of Science, 8.4.2019, National Chengchi University, Taipei, Taiwan

[7] P. Diko et al., Microstructure of glass coated Heusler alloy micro fibres, 17th International Symposium on Metallography, Fractography and Materials Science, 24.-26.4.2019, Nový Smokovec, High Tatras, Slovakia

[8] P. Samuely et al., Ising superconductovity in LaSeNbSe2, SUPERSTRIPES, May 2019, 28.6.2019, Ischia, Italy

[9] P. Kopčanský et al., Ferronematics- liquid crystal based sensors of magnetic field"15 EuropeanConference on Liquid Crystals, 30.6.-5.7.2019, Wroclaw, Poland

[10] P. Kopčanský et al., Magnetically anisotropic systems based on liquid crystals and magnetic fluids, 7th International Conference EURO-ASIAN SYMPOSIUM „TRENDS IN MAGNETISM", 8.-13.9.2019, Ekaterinburg, Russia

[11] S. Gabáni et al., Physical systems under high pressures, Cryocourse EMP, 14.9.2019, Zemplínska šírava, Slovakia

[12] P. Kopčanský et al., Magnetic fluid with liquid crystal – a tool to sensing low magnetic field, WORKSHOP: Magnetic nanoparticles, magnetoresponsive nanocomposites and characterization and applications, 19.-20.9.2019, Timisoara, Romania

[13] M. Timko et al., Magnetic field effect on thermal, dielectric and viscous properties of oil-based magnetic fluid, WORKSHOP: Magnetic nanoparticles, magnetoresponsive nanocomposites and characterization and applications, 19.-20.9.2019, Timisoara, Romania

[14] P. Kopčanský et al., Structure diagnostic of biorelevant associates and complexes in liquid nanosystems by small angle scattering, International conference MOLMED 2019, 25.-27.9.2019, India

[15] M. Timko et al., Hyperthermia in magnetic fluids as a tool for biomedical applications, International conference MOLMED 2019, 25.-27.9.2019, India

[16] K. Flachbart et al., Are SmB6 and YbB12 topological Kondo insulators?, Workshop, 28.9.2019, NIMS Tsukuba, Japan

[17] S. Gabáni et al., Pressure effect on superconducting YB6, Workshop, 28.9.2019, NIMS Tsukuba, Japan

[18] P. Szabó et al., Field dependent density of states observed above the upper critical magnetic field in strongly disordered MoC thin films", ELECTRON CORRELATION IN SUPERCONDUCTORS AND NANOSTRUCTURES (ECSN-2019), 6.-10.10.2019, Odessa, Ukraine

2020:

[1] I. Škorvánek et al., Soft Magnetic Amorphous and NanocrystallineBilayer Ribbons for GMI Sensors, TMS 2020 149-th Annual Meeting and Exhibition, 23.-27.2.2020, San Diego, California, USA

[2] M. Timko et al., Dielectric and rheological properties of a transformer oil based magnetic fluids, 16th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 49th Winter School on Wave and Quantum Acoustics, 24.-27.2.2020, Szczyrk, Poland

[3] P. Kopčanský et al., The study of structure of magnetic fluids and their composites by X-ray and neutrons, 16th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 49th Winter School on Wave and Quantum Acoustics, 24.-27.2.2020, Szczyrk, Poland

[4] I. Antal et al., Sono-magnetic heating with nanoparticles, 16th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods within the framework of the 49th Winter School on Wave and Quantum Acoustics, 24.-27.2.2020, Szczyrk, Poland

[5] M. Timko et al., New MAGnetic Biomaterials for Brain Repair and Imaging after Stroke, The International Conference on Nanoscience and Technology, 10.-14.3.2020, Stará Lesná, Slovakia

[6] M. Molčan et al., Flexible Magnetic Filaments: Properties and Applications, TheInternational Conference on Nanoscience and Technology, 10.-14.3.2020,Stará Lesná, Slovakia

[7] K. Šipošová et al., Dynamical Study of Formation/Destruction of Protein Amyloid Aggregates Targeted by Magnetic Zeolite Nanocomposites, The International Conference on Nanoscience and Technology, 10.-14.3.2020, Stará Lesná, Slovakia

[8] M. Rajňák et al., Magnetic fluids in electric fields: from structural changes to impedance transitions, The International Conference on Nanoscience and Technology, 10.-14.3.2020, Stará Lesná, Slovakia

[9] N. Tomašovičová et al., Self-assembly in nanocomposites, The International Conference on Nanoscience and Technology, 10.-14.3.2020, Stará Lesná, Slovakia

[10] S. Gabáni et al., Magnetic anisotropy of frustrated Shastry-Sutherland metallic systems TmB4 and ErB4, International Advanced Study Conference on Condensed Matter and Low Temperature Physics, 12.6.2020, Kharkiv, Ukraine

[11] P. Skyba et al., Superfluid helium-3 as model system for cosmology, Informal quantum symposium 2020, 24.8.2020, KC Smolenice, Slovakia

[12] P. Skyba et al., Magnonic Analog of Black/White-Hole Horizons in Superfluid 3He-B, 20th Conference of Czech and Slovak Physicists, 7.9.2020, Prague, Czech Republic (on-line)

[13] M. Mihalik et al., Structural and magnetic phase diagrams of RMn1-xFexO3 system with perovskite crystal structure, 20th Conference of Czech and Slovak Physicists, 8.9.2020, Prague, Czech Republic (on-line)

[14] J. Bednarčík, Study of thermal and mechanical stability of metallic glasses using synchrotron radiation, PETRA IV Workshop - Earth, Environment, and Materials for Nanoscience and Information Technology, 2.-4.11.2020, Hamburg, Germany (on-line)

2021:

[1] R. Pinčák, On PNDP-manifolds, 4th International Conference on Current Scenario in Pure and Applied Mathematics - ICCSPAM2021, Kongunadu Arts and Science College - Coimbatore - 641029, 29.-30.1.2021, Tamil Nadu, India

[2] S. Gabáni et al., Influence of pressure and stoichiometry on Ginzburg-Landau parameter in superconducting YB6, International Advanced Study Conference on Condensed Matter and Low Temperature Physics, 6.-12.6.2021, Kharkiv, Ukraine

[3] R. Pinčák, On PNDP-manifolds, 8th European Congress of Mathematics – 8 ECM, 20.-26.6.2021, Portorož, Slovenia

[4] S. Gabáni et al., Pressure effect on superconductivity in YB6, COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[5] M. Gmitra et al., Perspectives of proximity effects in transition-metal dichalcogenides and their heterostructures, COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[6] J. Kačmarčík et al., Unusual interplay between superconductivity and field induced charge order in YBa2Cu2Oy, COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[7] P. Skyba et al., Superfluid 3He-B and magnonic analogue of black/white horizon, COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[8] P. Szabó et al., Zeeman effects in homogeneous, strongly disordered superconducting MoC thin films, COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[9] O. Šofranko et al., Extremely doped bulk NbSe2 system in the misfit layered compound (LaSe)1.14(NbSe2), COST workshop Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Štrbské Pleso, Slovakia

[10] I. Škorvánek et al., Soft magnetic amorphous and nanocrystalline bilayer ribbons for sensor applications, The European Conference Physics of Magnetism PM´21, 28.6.-2.7.2021, Poznaň, Poland

[11] P. Skyba et al., A nonlinear damping of mechanical resonator in zero velocity limit in superfluid 3He-B – an evidence for the condensed matter analogue of the Unruh effect?, Workshop on Quantum matter at ultra-low temperatures, CMD 29, IOP, 21.7.2021, online series,
https://www.iopconferences.org/iop/frontend/reg/tOtherPage.csp?pageID=1030152&eventID=1661 &traceRedir=2

[12] P. Samuely et al., Zeeman-driven superconductor-insulator transition in strongly disordered MoC films. STM studies in transverse magnetic fields, International conference on Research in superconductivity and beyond (Gerasim Eliashberg memorial conference), 23.-26.8.2021, Chernogolovka, Russia

[13] P. Skyba et al., Heat transfer, Thermal isolation and thermal contact, Cryocourse 2021, 22.9.2021, Grenoble, France

[14] P. Szabó et al., High Spin Polarization in Co2FeSn Heusler Nanowires for Spintronics, Workshop on Low dimensional superconducting hybrids for novel quantum functionalities, 12.-14.10.2021, Paris, College de France

[15] P. Samuely et al., Quantum corrections to density of states of ultrathin strongly disordered superconducting MoC films, 7th International Conference on Supercnductivity and Magnetism - ICSM2021, 21.-27.10.2021, Milas-Bodrum, Turkey

[16] I. Škorvánek et al., Tailoring of GMI Sensor Characteristics of Soft Magnetic Ribbons by Layering and Magnetic Field Annealing, 7th International Conference on Superconductivity and Magnetism - ICSM2021, 21.-27.10.2021, Milas-Bodrum, Turkey

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

2016:

Kornel Csach, Pavel Diko – scientific committee
Mária Huráková – organising committee

16th International Symposium “Metallography and Fractography 2016“, 20.-22.4.2016, Stará Lesná, Slovakia

Ivan Škorvánek – chairman
Jozef Kováč, Natália Tomašovičová, Hana Čenčariková – publication committee
Jozef Marcin – program chairman
Karol Flachbart – advisory committee
Martina Koneracká, Milan Timko – organising committee
16th Czech and Slovak Conference on Magnetism, 13.-17.6.2016, Košice, Slovakia

Ivan Škorvánek – scientific committee
10th PAMIR International Conference Fundamental and Applied MHD, 20.-24.6.2016, Cagliari, Italy

Peter Skyba – organising, program and advisory committee
Quantum Fluids and Solids, 10.-16.8.2016, Prague, Czech Republic

Ladislav Šándor – member of the board of elders
46th International Symposium on Multiparticle Dynamics (ISMD 2016), 29.8.-2.9.2016, Jeju Island, South Korea

Dušan Bruncko – advisory committee
XXXVI Physics in Collision, 3.-18.9.2016, Quy Nhon, Vietnam

Michal Hnatič – chairman
Peter Kopčanský – organising committee
18th Small Triangle Meeting on theoretical physics (STM 2016), 16.-19.10., 2016, Ptíčie, Slovakia

2017:

Michal Hnatič – chairman
Peter Kopčanský – program committee
Mathematical Modeling and Computational Physics (MMCP 2017), 3.-7.7.2017, Dubna, Russia

Zuzana Bednáriková, Diana Fedunová, Zuzana Gažová, Miroslav Gančár, Igor Hrmo, Jana Kubacková, Katarína Uličná – organising committee
3rd NGP-NET SYMPOSIUM ON NON-GLOBULAR PROTEINS, 28.8.-1.9.2017, Košice, Slovakia

Diana Fedunová, Zuzana Gažová, Andrey Musatov, Zoltán Tomori – scientific committee
Zuzana Bednáriková, Miroslav Gančár, Igor Hrmo, Jana Kubacková, Katarína Šipošová, Dana Švarcbergerová, Katarína Uličná – organising committee
10th International Conference Structure and Stability of Biomacromolecules (SSB 2017), 4.-7.9.2017 Košice, Slovakia
Dušan Bruncko – advisory committee
XXXVII Physics in Collision, 4.-8.9.2017, Prague, Czech Republic

Milan Timko – program chairman
19th Conference of Czech and Slovak Physicists, 4.-7.9.2017, Prešov, Slovakia

Ivan Škorvánek – organizing committee
23rd Soft Magnetic Materials Conference (SMM 23), 10.-13.9.2017, Sevilla, Spain

Ladislav Šándor – member of the board of elders
47th International Symposium on Multiparticle Dynamics (ISMD 2017), 11.-15.9.2017, Tlaxcala City, Mexico

Peter Skyba – advisory committee
International Conference on Ultra Low Temperature Physics (ULT 2017), 17.-21.9.2017, Heidelberg, Germany

Dušan Bruncko – organising committee
ATLAS Overview Week, 9.-13.10.2017, Bratislava, Slovakia

Pavol Stríženec – organising committee
ATLAS Overview Week, 9.-13.10.2017, Bratislava, Slovakia

Michal Hnatič – chairman
Peter Kopčanský – organising committee
19th Small Triangle Meeting on theoretical physics (STM 2017), 15.-18.10., 2017, Medzilaborce, Slovakia

Peter Kopčanský – organising committee
Milan Timko – advisory committee
International Conference on biological application of nanoparticles, Chennai, India, 225 participants, 4.-5.12.2017

2018:

Pavol Stríženec – head of the organising committee
RECFA Meeting Bratislava, 18.-19.5.2018, Bratislava, Slovakia

Marián Sedlák – scientific committee
European Colloid and Interface Society Symposium (ECIS 2018), 3.-7.9.2018, Ljubljana, Slovenia

Ladislav Šándor – member of the board of elders
48th International Symposium on Multiparticle Dynamics (ISMD 2018), 3.-7.9.2018, Singapore, Singapore

Michal Hnatič – chairman
Peter Kopčanský – organising committee
20th Small Triangle Meeting on theoretical physics (STM 2018), 7.-10.10., 2018, Príčie, Slovakia

2019:

Kornel Csach, Pavel Diko – scientific committee
Mária Demčáková, Alena Juríková – organising committee
17th International Symposium “Metallography and Fractography 2019“, 24.-26.4.2019, Nový Smokovec, Slovakia

Ivan Škorvánek – chairman
Jozef Kováč, Hana Čenčariková, Michal Rajňák – publication committee
Jozef Marcin – program chairman
Karol Flachbart – advisory committee
Martina Koneracká – organising committee
17th Czech and Slovak Conference on Magnetism, 3.-7.6.2019, Košice, Slovakia

Hana Čenčariková (Vargová) – organising committee
Workshop on Quantum Magnetism: Theoretical Challenges and Future Perspectives, 7.-8.6.2019, Košice, Slovakia

Michal Hnatič, Peter Kopčanský – program and organising committee

Mathematical Modeling and Computational Physics (MMCP 2019), 1.-5.7.2019, Stará Lesná, Slovakia

Ivan Škorvánek – scientific committee
11th PAMIR International Conference Fundamental and Applied MHD, 1.-5.7.2019, Reims, France

Pavel Diko – chairman
11th International Workshop on Processing and Applications of Superconducting Bulk Materials (PASREG 2019), 29.-30.8.2019, Prague, Czech Republic

Diana Fedunová, Zuzana Gažová, Andrey Musatov – scientific committee
Zuzana Bednáriková, Miroslav Gančár, Igor Hrmo, Jana Kubacková, Katarína Šipošová, Dana Švarcbergerová, Vladimír Vaník, Andrea Antošová – organising committee
11th International Conference Structure and Stability of Biomacromolecules (SSB 2019), 3.-6.9.2019 Košice, Slovakia

Ivan Škorvánek – organizing committee
24th Soft Magnetic Materials Conference (SMM 24), 4.-7.9.2019, Poznan, Poland

Peter Skyba – chairman
Marcel Človečko, Slavomír Gabáni, Emil Gažo, Jozef Kačmarčík, Marcela Medeová, Pavol Szabó, Zuzana Vargaeštoková – organising committee
International advanced school on low and ultra-low temperature physics, cryogenics, experimental measurement techniques and engineering for quantum technology (Cryocourse 2019), 8.-19.9.2019, Zemplínska šírava and Košice, Slovakia

Michal Hnatič – chairman
Peter Kopčanský – organising committee
21th Small Triangle Meeting on theoretical physics (STM 2019), 6.-9.10., 2019, Spišské Tomášovce, Slovakia

2020:

Peter Kopčanský – chairman
International Conference on Nanoscience and Technology (BIONANOSMART 2020), 10.-13.3.2020, Stará Lesná, Slovakia

Milan Timko – program chairman
20th Conference of Czech and Slovak Physicists, 7.-10.9.2020, Prague, Czech Republic

Michal Hnatič – chairman
22nd Small Triangle Meeting on theoretical physics (STM 2020), 7.-10.10.2020, Spišské Tomášovce, Slovakia

2021:

Marcel Človečko, Peter Skyba – organising committee
European Microkelvin Platform: evaluation user on-line meeting, 29.3.2021

Pavol Szabó – chairman
Jozef Kačmarčík, Peter Samuely – program and organising committee
Superconducting Hybrids @ Extreme, 28.6.-2.7.2021, Hotel Patria, Štrbské Pleso, Slovakia

Michal Hnatič – chairman
International Conference on Precision Physics and Fundamental Physical Constants 2021, 4.-8.10.2021, KC Akadémia, Stará Lesná

Michal Hnatič – chairman
Hnatičová, Reiffers, Remecký – organising committee
23rd Small Triangle Meeting on theoretical physics (STM 2021), 18.-22.10.2021, Slovenský raj, Slovakia

2.3.9. List of researchers who received an international scientific award

The scientists of IEP SAS are:
- experts of the national government and the SAS in different fields of research
- referees of the most reputable scientific journals, like Science, Nature, Physical Review Letters, Physical Review B, E, Journal of Alloys and Compounds, Biomacromolecules, etc.
- referees, reporters and panelists of FP7 and H2020 projects, foreign grant agencies, etc.
- members of scientific societies, like European Physical Society, IUPAP, European High Pressure Research Group, European Biophysical Societies´s Association, etc.

Baláž Ján
European Space Agency Certificate for Recognition of Outstanding Contribution to the ESA Rosetta Mission, 2017

Corresponding Member in Section Engineering sciences elected by International Academy of Astronautics, 2019

Bruncko Dušan
Ernst Mach Honorary Medal for Merit in Physical Sciences of the Academy of Sciences of the Czech Republic, 2018

Mušinský Ján
The First Prize of the Joint Institute for Nuclear Research Dubna Award for the work "*Measurement of analyzing powers for nucleon-nucleus scattering at momentum range from 1.75 to 5.4 GeV/c*", 2021

Bednáriková Zuzana
IUPAB Young Travel Award of the European Biophysical Societies´ Association on 19th IUPAB/11th EBSA congress, Edinburgh, Great Britain, 2017

Travel Award of the European Biophysical Societies´ Association on 13th European Biophysics Conference, Vienna, 2021

Borovská Barbora
Student poster award of the European Biophysical Societies´ Association on 13th European Biophysics Conference, Vienna, 2021

Travel Award of the European Biophysical Societies´ Association on 13th European Biophysics Conference, Vienna, 2021

Hajdová Petra
Best Presenter Award of the Scientific committee of 10th International Workshop on Processing and Applications of Superconducting (RE)BCO Large Grain Materials (PASREG 2017), SIT Tokyo, 2017

Šipošová Katarína
Danubius Young Scientist Award of the Austrian Federal Ministry of Science, Research and Economics (BMWFW) and Institute for Danube Region and Central Europe (IDM), 2017

The best poster presentation among young scientist award of the Scientific committee of International Conference "Condensed Matter Research at the IBR-2", 2017

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

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

[1] K. Kudela: Kvázi-periodické variácie kozmického žiarenia na zemskom povrchu: niekoľko poznámok, 23. celoštátny slnečný seminár, 2016, Liptovský Mikuláš

[2] Ján Baláž, Misia ROSETTA – prvé pristátie v histórii na kométe, 22. konferencia slovenských fyzikov, 5.-8.9.2016, Košice

[3] Pavol Bobík, JEM-EUSO experiment, hľadanie najenergetickejších častíc vo vesmíre, 22. konferencia slovenských fyzikov, 5.-8.9.2016, Košice

[4] J. Kačmarčík, Nízke teploty a supravodivosť, Kalibračné združenie SR XLVII, Zhromaždenie KZ SR spojené s odbornou konferenciou, november 2017, Spišská Nová Ves

[5] P. Kopčanský et al., Magnetic Fluids and their composites, Workshop of The Slovak Academy of Sciences with The National University of Singapore, the Nanyang Technological University and The Agency for Science, Technology and Research Singapore, 13.-17.3.2017, Smolenice

[6] P. Samuely et al., Two cases of 2D superconductors. Superconductor-isolator transition in disordered ultrathin films. Ising superconductivity, Workshop of The Slovak Academy of Sciences with The National University of Singapore, the Nanyang Technological University and The Agency for Science, Technology and Research Singapore. 13.-17.3.2017, Smolenice

[7] Z. Bednáriková et al., A novel approach to treating Alzheimer´s disease? Photoswitchable molecules, 8th Slovak Biophysical Symposium, 30.5.-1.6. 2018, Košice

[8] Z. Bednáriková et al., Effect of natural and synthetic small molecules on aggregation of globular proteins, 8th Slovak Biophysical Symposium, 30.5.-1.6. 2018, Košice

[9] S. Gabáni et al., Pressure effect on superconductivity od YB6. 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[10] M. Mihalik et al., Structural amg magnetic phase diagrams of RMn1-xFexO3 system, 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[11] V. Lacková et al., Structuralization processes in composites materials based on liquid crystals doped with magnetic nanoparticles, 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[12] M. Rajňák et al., Experimental study of magnetic fluids for electrical engineering applications, 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[13] P. Szabó et al., Superconductor-insulator transition. 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[14] K. Šipošová et al., Interactions of Nanoparticles with Proteins: Biomedical Applications, 23rd Conference of Slovak physicists, 5.-8.9.2018, Smolenice

[15] V. Lacková et al., Tuning the phase transition temperature of ferronematics with a magnetic field, Small Triangle Meeting, 7.- 10.10.2018, Ptíčie

[16] M. Rajňák et al., The use of neutron scattering in the study of magnetic fluids in electric fields, SFEL2018, 27.-31.5.2018, Liptovský Ján

[17] I. Škorvánek et al., Amorphous and nanocrystalline bilayer ribbon composites for magnetic sensors, Vedecká konferencia - Funkčné kompozitné materiály, 16.10.2018, Košice

[18] V. Lacková et al., Ferronematics- nanofluids based on lquid crystals and magnetic nanoparticles, 24th Conference of Slovak physicists, 2.-5.9.2019, Žilina

[19] Š. Mackovjak, Space science, engineering, and educational activities at Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences, 20.-22.10.2020, Celoštátny slnečný seminár 2020, Hurbanovo (on-line)

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

Ivan Škorvánek – program committee
Senzorika a magnetometria, 8.12.2016, Košice, Slovakia

Milan Timko – program chairman
23rd Conference of Slovak Physicists, 5.-8.9.2018, Smolenice, Slovakia

Ivan Škorvánek – program committee
Senzorika a magnetometria, 6.12.2018, Košice, Slovakia

Milan Timko – program chairman
24th Conference of Slovak Physicists, 2.-5.9.2019, Žilina, Slovakia

Ivan Škorvánek – program committee
Senzorika a magnetometria, 3.12.2020, Košice, Slovakia

Milan Timko – program chairman
Michal Rajňák – program committee
25th Conference of Slovak Physicists, 6.-9.9.2021, Bratislava, Slovakia

2.3.12. List of researchers who received a national scientific award

2016

Baláž Ján
The Slovak Academy of Sciences Award for the Popularization of Science and Social Application of Science

Kudela Karel
Recognition as a Prominent Personality of the Slovak Academy of Sciences

Zentková Mária
The Slovak Academy of Sciences Award for the Popularization of Science and Social Application of Science

2017

Šipošová Katarína
The Slovak Academy of Sciences Award for the 3rd prize in Young researcher´s competition for the work: „*Amyloid state of proteins and amyloid diseases. Progress and problems on the way to an effective therapist*“

Bednáriková Zuzana
The Slovak Biophysical Society and Scientific Committee Award for Young Scientists on 10th International Conference "Structure and Stability of Biomacromolecules"

Gančár Miroslav
Institute of Animal Physiology CBS SAS Award in the Competition of the Best Scientific Work of PhD Students on 12th Seminar of doctoral students dedicated to the memory of the academic Boďa

2018

Bílek Richard, Kuľková Ingrid, Straka Miloslav, Vaľa Martin
The Slovak Academy of Sciences Award for the Building Infrastructure for Science:
For building, development and maintenance of a computing node of the Worldwide LHC Grid network in the high energy physics used for the data processing for experiments at the Large Hadron Collider at CERN

Bednáriková Zuzana
The Slovak Biophysical Society Award for Young Scientist

Gančár Miroslav
TOP 15 Flash presentations – Interactive conference for young scientists PREVEDA

Skyba Peter
The Slovak Physical Society Award for Science

2019

IEP SAS
P.J. Safarik University Gold medal for the Development of Slovak higher education and long-term cooperation in the field of science and education

Kačmarčík Jozef
The Slovak Academy of Sciences Award for the Nature Index publication:
Unusual interplay between superconductivity and field-induced charge order in $YBa_2Cu_3O_y$
Physical Review Letters 121, 167002 (2018)

Gančár Miroslav
The Slovak Biophysical Society Award for The Best Oral Presentation

Gažová Zuzana, Antošová Andrea, Bednáriková Zuzana, Fedunová Diana, Marek Jozef
Science and Technology Award of the Ministry of Education, Science, Research and Sport of SR in category the Scientific-Technical Team of the Year:
For scientific contribution in the field of amyloid protein aggregation and identification of substances suitable for the treatment of dieseases associated with amyloid protein aggregation

Rajňák Michal
The Slovak Physical Society Award for the 3rd prize in the Competition of Scientific Works of Young Physicists

Tomašovičová Natália
P.J. Safarik University Rector´s Award for a Significant Media Act and Media Response to the Organization of the Exhibition „Human Tear as Art“

Zentková Mária
Science and Technology Award of the Ministry of Education, Science, Research and Sport of SR in category the Popularization of Science

2020

Človečko Marcel, Gažo Emil, Kupka Martin, Skyba Peter
The Slovak Academy of Sciences Award for the Nature Index publication:
Magnonic Analog of Black- and White-Hole Horizons in Superfluid ^{3}He-B
Physical Review Letters 123, 161302 (2019)

Jurčišin Marián, Jurčišinová Eva
The Slovak Academy of Sciences Award for the Results of Scientific Research Work in 2019 for a set of results achieved in the study of thermodynamic properties of frustrated magnetic systems

Kačmarčík Jozef
The Slovak Academy of Sciences Award in the category of Top-level publications:
Thermodynamic signatures of quantum criticality in cuprate superconductors
Nature 567, 2018-222 (2019)

Kuzmiak Marek
The Slovak Academy of Sciences Certificate of High Quality Submitted Project DoktoGrant Project APP0160 "*Determination of phase stiffness parameter in superconductors*"

Mackovjak Šimon
The Slovak Academy of Sciences Award for the Popularization of Science and Social Applications of Science:
For SPACE::LAB - a place for the interest, education and involvement of the young generation in space research and engineering

Ovadová Michaela, Rak Dmytro, Sedlák Marián
The Slovak Academy of Sciences Award for the Nature Index publication:
(Non)Existence of Bulk Nanobubbles: The Role of Ultrasonic Cavitation and Organic Solutes in Water, Journal of Physical Chemistry Letters 10, 4215 (2019)

Rajňák Michal
The Slovak Academy of Sciences Award for the Results of Scientific Research Work for Young Workers:
For significant results in the field of Magnetic fluids for electrical applications

Rak Dmytro
The Slovak Academy of Sciences Award for the 1st prize in Young researcher´s competition

Spodniaková Barbora
The Slovak Academy of Sciences Certificate of High Quality Submitted Project DoktoGrant Project APP0203 “Identification of protein amyloid aggregarion inhibitors using molecular hybridization"

Orendáč Matúš
The Slovak Physical Society Award for the 1st prize in the Competition of Scientific Works of Young Physicists

Rajňák Michal
The Slovak Physical Society Award for Science

Regeciová Ľubomíra
The Slovak Physical Society Award for the 3rd prize in the Competition of Scientific Works of Young Physicists

Skyba Peter
The Scientist of the Year SR 2019
Award of the Slovak Centre of Scientific and Technical Information SR, the Slovak Academy of Sciences and the Association of Slovak Scientific and Technological Societies
For the scientific results achieved in the study of the properties of condensed matters at very low temperatures, especially superfluid helium-3 as a model system for cosmology, and for the development of physics of very low temperatures in Slovakia

Spodniaková Barbora
Institute of Animal Physiology CBS SAS Award in the Competition of the Best Scientific Work of PhD Students on 15th Seminar of doctoral students dedicated to the memory of the academic Boďa

Zakuťanská Katarína
The Slovak Physical Society Award for the 1st prize in the Competition of Scientific Works of Young Physicists

2021

Človečko Marcel
The Slovak Academy of Sciences Award for the Nature Index publication:
Quartz tuning fork – A potential low temperature thermometer in high magnetic fields
Applied Physics Letters 115, 193507 (2019)

Orendáč Matúš
The Slovak Academy of Sciences Award for the 3rd prize in Young researcher´s competition

Zakuťanská Katarína
The Slovak Academy of Sciences Award for the 1st prize in PhD student´s competition

Garčárová Ivana
PREVEDA Award for excellent results at 13th Interactive Conference of Young Researchers

Regeciová Ľubomíra
The Slovak Physical Society Award for the 3rd prize in the Competition of Scientific Works of Young Physicists

Skyba Peter
Prominent Personality of the Slovak Science
Award of the Slovak Centre of Scientific and Technical Information SR

2.4. Research grants and other funding resources

(List 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". Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

2.4.1. List of major projects of Framework Programmes of the EU (which pilar), NATO, COST, etc.

Start	Project title	Project number	Duration	Funding: Total / For the Institute (EUR)	Role of the Institute / Responsible person
- 2016	Extreme Universe Space Observatory Onboard Japan Experiment Module	JEM-EUSO	1.1.2010 / 31.12.2021	225 500 225 500	W / Bobík
	Nanoscale Superconductivity: Novel Functionalities through Optimized Confinement of Condensate and Fields	COST Action MP1201	19.10.2012 / 18.10.2016	15 917 15 917	W / Samuely
	Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy	COST Action TD1402	13.11.2014 / 12.11.2018	15 424 15 424	W / Kopčanský
	Non-globular proteins - from sequence to structure, function and application in molecular physiopathology	COST Action BM1405	27.7.2015 / 25.3.2019	14 362 14 362	W / Gažová
	Overcoming Barriers to Nanofluids Market Uptake	COST Action CA15119	19.4.2016 / 18.4.2020	15 199 15 199	C / Timko
	Feasibility study to observe ionospheric disturbances by one pixel UV detector	ESA PECS 4000117740	1.6.2016 / 30.4.2018	49 864 49 864	C / Bobík
	Effect of small molecules and nanoparticles on amyloid aggregation of polypeptidas	JRP	1.6.2016 / 31.12.2018	75 000 75 000	W / Gažová
	ALICE experiment at the CERN LHC: The study of strongly interacting matter under extreme conditions	CERN ME ALICE 0206/2016	1.1.2016 / 31.12.2020	312 500 312 500	C / Králik
	ATLAS experiment on LHC in CERN: deep-inelastic events and new physics at TeV energies	CERN ME ATLAS 0207/2016	1.1.2016 / 31.12.2020	315 500 315 500	C / Bruncko
2017	Nanoscale Coherent Hybrid Devices for Quantum Technologies	COST Action CA16218	18.10.2017 / 17.4.2022	15 229 15 229	W / Samuely
2018	Development and production of water-dispersible radionuclide labeled magnetic nanoparticles	EUREKA E!9982	1.1.2018 / 31.12.2020	30 000 15 000	C / Koneracká

	Dynamical study of formation/destruction of protein amyloid aggregatess targeted by magnetic zeolite nanocomposites	**JRP AMAZON**	**1.1.2018 / 31.12.2020**	**75 000 75 000**	**W / Kopčanský**
	Novel soft magnetic cores tailored for use in space qualified magnetometers and satellite devices	**JRP MAGSAT**	**1.9.2018 / 31.8.2021**	**37 500 37 500**	**W / Škorvánek**
	Follow-up of feasibility study to observe ionospheric disturbances by airglow monitoring network (AMON-net)	**ESA PECS 4000125330**	**1.10.2018 / 30.9.2020**	**177 096 177 096**	**C / Mackovjak**
	Slovak contribution to ESA-JUICE mission: Development of Anti-Coincidence Module ACM for Particle Environment Package PEP	**ESA PECS 4000125788**	**15.11.2018 / 30.10.2020**	**172 178 172 178**	**C / Baláž**
	SPACE:LAB - place to attract, educate and involve young generation in space science and engineering	**ESA PECS 4000125987**	**1.12.2018 / 30.11.2020**	**40 688 40 688**	**C / Mackovjak**
2019	**European Microkelvin Platform**	**H2020 824109**	**1.1.2019 / 30.6.2023**	**9 941 066 1 062 735**	**W / Skyba**
	Enhancement of superconducting T_c in 2D thin films under pressure	**ERC Visiting Fellowship**	**3.2.2019 / 5.3.2019**	**4 000 4 000**	**W / Pristáš**
2020	**Nanofluids for convective heat transfer devices NANOConVEX CIG**	**COST Action 15119**	**1.5.2020 / 30.4.2021**	**3 250 3 250**	**W / Timko**
	Novel composities based on cerium oxide nanoparticles and carbon enterosorbents for acute radiation sickness therapy	**NATO G-5683**	**15.7.2020 / 14.7.2023**	**118 910 58 440**	**W / Musatov**
	Space Ionizing Radiation Experts Nursery	**ESA PECS 4000132782**	**1.1.2020 / 31.12.2022**	**29 964 29 964**	**C / Langer**
	Development of energetic particle spectrometer ASPECT-L for lunar mission Luna-26 (Orbital module)	**Luna-26 Orbiter**	**1.6.2020 / 24.2.2022**	**4 590 4 590**	**W / Baláž**
2021	**Slovakia National Space Safety Programme (S2P) Study**	**ESA PECS 4000136251**	**1.1.2021 / 31.12.2022**	**49 910 9 000**	**W / Mackovjak**
	ATLAS experiment on LHC at CERN: deep-inelastic precesses and new physics at TeV energies	**CERN ME ATLAS 0198/2021**	**1.1.2021 / 31.12.2021**	**67 000 67 000**	**C / Stríženec**
	The ALICE experiment at the CERN LHC: Study of the strongly interacting matter under extreme conditions	**CERN ME ALICE 0199/2021**	**1.1.2021 / 31.12.2021**	**61 000 61 000**	**C / Králik**

JEM-EUSO (Japanese Experiment Module - Extreme Universe Space Observatory), 2010-2022, is an experiment devoted to explore the origin of the ultra high energy cosmic rays. JEM-EUSO experiment is a common project of 16 collaborating countries including Slovak republic. Slovak contribution is represented by Department of Space Physics at Institute of Experimental Physics Slovak Academy of Sciences in Košice since 2008. National coordinator: Pavol Bobík – W

COST Action MP1201 *Nanoscale Superconductivity: Novel Functionalities through Optimized Confinement of Condensate and Fields (NanoSC-COST)***,** 2012-2016. National coordinator: Peter Samuely – W

COST Action TD 1402 *Multifunctional Nanoparticles for Magnetic Hyperthermia and Indirect Radiation Therapy (RADIOMAG),* 2014-2018. Our group in the frame of this project is participating on synthesis of magnetic particles, and coating by biocompatible organic agents containing appropriate functional groups, that allow binding of antibodies specific to tumour cells. By applying alternating magnetic field onto the cells with magnetic particles, magnetic particles absorb energy and converts into heat and the heating effect could help to destroy cancer cells. Moreover, our group will also prepare magnetosomes by biomineralization process which are suitable for hyperthermia thanks to higher SAR value. Tumour treatment after application of specially designed magnetic nanoparticles and application of magnetic hyperthermia would be potentially more efficient. National coordinator: Peter Kopčanský - W

COST Action BM1405 *Non-globular proteins - from sequence to structure, function and application in molecular physiopathology (NGP-NET)***,** 2015-2019. The aim of the project is to create a pan-European scientific network of groups that work on non-globular proteins (NGPs) to strengthen, focus and coordinate research in this field. Non-globular proteins encompass different molecular phenomena that defy the traditional sequence-structure-function paradigm. Although growing evidence suggests that NGPs are central to many human diseases, functional annotation is very limited. Therefore, a better understanding of NGPs is crucial to fully comprehend human molecular physiopathology. The progress can be obtained using a systematic approach to their study supported by this project. National coordinator: Zuzana Gažová – W

COST Action CA16218 *Nanoscale Coherent Hybrid Devices for Quantum Technologies (NANOCOHYBRID)***,** 2017-2022. In frame of this project a mobility network of European laboratories working in the field of superconductivity and superconducting nanostructures was created. The purpose of this Virtual Institute is to improve the availability of EU infrastructure and knowledge, and focus on support of young researchers. National coordinator: Peter Samuely – W

EMP H2020 824109 *European Microkelvin Platform*, 2019-2023. The European Microkelvin Platform (Improved platform for ultra-low temperature physics research) is an advanced European research infrastructure in the field of ultra-low temperature and ultra-sensitive measurement techniques with a specific focus on quantum technologies and quantum materials. The platform is continuously evolving, building on the advances achieved through previous infrastructure calls. A consortium of 17 partners from both academia and the private sector joined forces in the EU-funded EMP project to provide a comprehensive portfolio of capabilities to enhance the European research effort and innovation potential in ultra-low temperature physics. Partners will focus on improving and upgrading the infrastructure since the lowest accessible temperatures are continuously falling. National coordinator: Peter Skyba – W and member of the Executive Board.

NATO G5683 *Novel composities based on cerium oxide nanoparticles and carbon enterosorbents for acute radiation sickness therapy*, 2020-2023. The project is dedicated to the development and preparation of new nanocomposites designed for the treatment of diseases after acute irradiation. Attention is focused on the combined use of uncoated cerium oxide nanoparticles and a highly active carbon enterosorbent intended for oral use. Initial results suggest that new nanocomposites prepared by a unique combination of

biomaterials can reduce oxidative stress, stabilize the structural and functional integrity of plasma proteins, and significantly increase the regenerative potential of bone marrow, liver, and kidney. The practical result of the project will be the experimental implementation of a completely new approach to the treatment of acute radiation, which will be compatible with classical cytokine therapy. We expect that the research will lead to the design of new effective (active) preparations ready for testing in preclinical studies. National coordinator: Andrey Musatov – W

CERN, CDF, JINR DUBNA

The participation of Slovakia in scientific programs of the CERN is supported at governmental level. The participation in the CERN experimental programm has been a backbone of our research activities in the field of high energy physics for almost 25 years. The research of the Department of Subnuclear physics has been mainly supported by the CERN / ME SR projects:

CERN ME ALICE 0206/2016 ALICE experiment at the CERN LHC: The study of strongly interacting matter under extreme conditions. Duration: 1.1.2016 / 31.12.2020. Responsible person: Ivan Králik – C

CERN ME ALICE 0199/2021 The ALICE experiment at the CERN LHC: Study of the strongly interacting matter under extreme conditions. Duration: 1.1.2021 / 31.12.2021. Responsible person: Ivan Králik – C

CERN ME ATLAS 0207/2016 ATLAS experiment on LHC in CERN: deep-inelastic events and new physics at TeV energies. Duration: 1.1.2016 / 31.12.2020. Responsible person: Dušan Bruncko – C

CERN ME ATLAS 0198/2021 ATLAS experiment on LHC at CERN: deep-inelastic precesses and new physics at TeV energies. Duration: 1.1.2021 / 31.12.2021. Responsible person: Pavol Stríženec – C

JINR Dubna: The Department of Theoretical Physics has a very fruitful collaboration with the Laboratory of Theoretical Physics in Dubna (Russian Federation) focused on the application of quantum field theory in stochastic dynamics. Department of Subnuclear Physics maintains contacts with a group participating at the ALICE experiment at CERN studying the production of resonances.

Add information on your activities in international networks

- **National projects, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

Start	Project title	Acronym	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
- 2016	Magnetically active anisotropic composite systems	MACOSYS	1.9.2013 / 31.8.2016	75 000	C / Kopčanský
2018	Flexible Magnetic Filaments: Properties and Applications	FMF	1.9.2018 / 30.6.2022	75 000	W / Kopčanský
	New MAGnetic Biomaterials for Brain Repair and Imaging after Stroke	MAGBBRIS	1.3.2018 / 28.2.2021	75 000	W / Kopčanský

2019	**Theoretical and Experimental Study of Transition Metal Oxyhydride Nanomaterials for Superconductivity and Photocatalysis**	**TESTIMONIES**	**1.10.2019 / 31.12.2022**	**75 000**	**W / Flachbart**
2021	**2Dimensional van der Waals Spin-Orbit Torque Technology**	**2DSOTECH**	**1.12.2021 / 29.11.2024**	**75 000**	**W / Gmitra**

2.4.3. List of projects of the Slovak Research and Development Agency, APVV

General calls:

Start	Project title	Project number	Duration	Funding: Total / For the Institute (EUR)	Role of the Institute / Responsible person
- 2016	**Collective phenomena in coupled electron and spin systems**	**APVV-0097-12**	**1.10.2013 / 31.12.2016**	**117 357 62 349**	**C / Farkašovský**
	Bulk Superconductors	**APVV-0330-12**	**1.10.2013 / 30.9.2017**	**249 998 249 998**	**C / Diko**
	Graphene-based nanoplatform for detection of cancer	**APVV-14-0120**	**1.7.2015 / 30.6.2019**	**246 332 50 177**	**W / Koneracká**
	Superconductor-insulator transition (project with significant results)	**APVV-14-0605**	**1.7.2015 / 30.6.2019**	**249 998 138 499**	**C / Szabó**
	Effects of nanoencapsulated simvastatin on cardiovascular system in experimental metabolic syndrome	**APVV-14-0932**	**1.7.2015 / 30.6.2019**	**246 375 43 145**	**W / Závišová**
	Design of the structure and the functional properties of soft magnetic 3-d transitions metals based composites	**APVV-15-0115**	**1.7.2016 / 31.12.2019**	**249 777 19 960**	**W / Baťková**
	Low energy cosmic rays, suprathermal particles and space weather	**APVV-15-0194**	**1.7.2016 / 27.12.2017**	**90 095 84 630**	**C / Kudela**
	Nanoparticles in anisotropic systems	**APVV-15-0453**	**1.7.2016 / 30.6.2020**	**246 320 246 320**	**C / Kopčanský**
	Atomic structure and exceptional properties of intermetallics, amorphous, nanocrystalline and complex metallic alloys (project with significant results)	**APVV-15-0621**	**1.7.2016 / 31.12.2019**	**249 510 123 567**	**W / Škorvánek**
	Image analysis of microscopic particles in the automation of optical manipulation techniques applicable in mikro/nanorobotics	**APVV-15-0665**	**1.7.2016 / 31.12.2019**	**159 885 159 885**	**C / Tomori**

2017	Exotic quantum states of low-dimensional spin and electron systems	APVV-16-0186	1.7.2017 / 30.6.2021	170 000 17 764	W / Čenčariková
	Quantum Technologies, Materials and Devices	APVV-16-0372	1.7.2017 / 31.12.2020	230 000 115 142	W / Samuely
	Nanosegregation in soft matter of polymeric and nonpolymeric nature	APVV-16-0550	1.7.2017 / 31.12.2020	128 713 128 713	C / Sedlák
2018	Frustrated metallic magnetic systems	APVV-17-0020	1.8.2018 / 30.6.2022	166 496 146 832	C / Gabáni
	Development of REBCO superconductors for biomedical applications	APVV-17-0625	1.8.2018 / 30.6.2022	249 686 227 686	C / Diko
2019	Nanofluids in Electrical Engineering	APVV-18-0160	1.7.2019 / 30.6.2023	249 496 84 494	C / Rajňák
	Multi-target inhibitors of poly/peptides associated with Alzheimer´s disease	APVV-18-0284	1.7.2019 / 1.6.2023	134 532 134 532	C / Gažová
	Electron correlations in disordered superconductors	APVV-18-0358	1.7.2019 / 30.6.2023	210 000 134 340	C / Szabó
2020	The development of translationally relevant regenerative and reparative strategies after spinal cord trauma	APVV-19-0324	1.7.2020 / 30.6.2024	220 000 44 000	W / Musatov
	Novel nano/micro-structured metallic materials prepared by unconventional processing routes	APVV-19-0369	1.7.2020 / 30.6.2024	249 895 122 695	W / Škorvánek
2021	Perspective electronic spin systems for future quantum Technologies	APVV-20-0150	1.7.2021 / 30.6.2025	190 000 18 541	W / Vargová
	Theoretical study of frustrated magnetic systems	APVV-20-0293	1.7.2021 / 30.6.2025	120 000 120 000	C / Jurčišin
	Electrocatalysts for efficient hydrogen production for future electrolysers and fuel cells	APVV 20-0299	1.7.2021 / 30.6.2025	210 478 14 000	W / Baťková
	Topologically nontrivial magnetic and superconducting structures	APVV-20-0425	1.7.2021 / 30.6.2025	230 000 46 000	W / Samuely

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

VEGA	2016	2017	2018	2019	2020	2021	2016-2021
Number	**27**	**27**	**29**	**31**	**30**	**29**	**64**
Funding in the year (EUR)	**198 293**	**206 429**	**188 581**	**179 718**	**176 285**	**173 140**	**1 122 446**

Number of VEGA projects with significant results = 9

VEGA 2/0045/13 – significant results
Sensitivity of liquid crystals containing nanoparticles to external magnetic field
Duration: 1.1.2013 / 31.12.2016
Responsible person: **Peter Kopčanský / C**

VEGA 2/0093/13
Study of properties of turbulent environments with symmetry breaking
Duration: 1.1.2013 / 31.12.2016
Responsible person: Marián Jurčišin / C

VEGA 2/0181/13 – significant results
Inhibitors of protein amyloid aggregation
Duration: 1.1.2013 / 31.12.2016
Responsible person: **Zuzana Gažová / C**

VEGA 2/0184/13
Thin films and thin film structures for sensoric and memristive applications
Duration: 1.1.2013 / 31.12.2016
Responsible person: Marianna Baťková / C

VEGA 2/0020/14
Properties of nuclear matter created in interactions with nuclear targets at high energies
Duration: 1.1.2014 / 31.12.2017
Responsible person: Ján Nemčík / C

VEGA 2/0045/14 – significant results
Mechanical properties and stability of amorphous alloys and nanosized systems
Duration: 1.1.2014 / 31.12.2017
Responsible person: **Kornel Csach / C**

VEGA 2/0062/14 – significant results
Functionality and structural integrity of proteins in bicelles – implications for mitochondrial and amyloidogenic proteins
Duration: 1.1.2014 / 31.12.2016
Responsible person: **Andrey Musatov / C**

VEGA 2/0175/14
Development and implementation of algorithms and methods for the study of fiber like objects using image processing and mathematical modeling
Duration: 1.1.2014 / 31.12.2016
Responsible person: Erna Demjén / C

VEGA 2/0176/14
Study of the intrinsically disordered protein stability and aggregation

Duration: 1.1.2014 / 31.12.2017
Responsible person: Diana Fedunová / C

VEGA 2/0182/14
Spontaneously occurring and induced target-oriented self-assembly of polymeric and nonpolymeric materials in liquid state
Duration: 1.1.2014 / 31.12.2016
Responsible person: Marián Sedlák / C

VEGA 2/0157/15
Superfluid helium-3 as topological insulator
Duration: 1.1.2015 / 31.12.2017
Responsible person: Peter Skyba / C

VEGA 1/0409/15
Study of superconducting nanostructures and nanolayers
Duration: 1.1.2015 / 31.12.2018
Responsible person: Peter Samuely / W

VEGA 2/0010/16
Effect of extreme environment (magnetic field, pressure, temperature) on the anomalous behavior of the ground state and phase transitions in strongly correlated materials Duration:
Duration: 1.1.2016 / 31.12.2018
Responsible person: Matúš Mihálik / C

VEGA 2/0026/16
Variability of cosmic ray flux measured on Earth's surface
Duration: 1.1.2016 / 31.12.2017
Responsible person: Karel Kudela / C

VEGA 2/0032/16 – significant results
Influence of extreme conditions on strongly correlated electron systems
Duration: 1.1.2016 / 31.12.2019
Responsible person: **Slavomír Gabáni / C**

VEGA 2/0038/16
Supramolecular complexes of biomacromolecules
Duration: 1.1.2016 / 31.12.2019
Responsible person: Eva Valušová / C

VEGA 1/0043/16
Magnetoelectric and magnetocaloric effect in exactly solvable lattice-statistical models
Duration: 1.1.2016 / 31.12.2019
Responsible person: Hana Čenčariková / W

VEGA 2/0077/16
Satellite detectors for space physics research
Duration: 1.1.2016 / 31.12.2018
Responsible person: Ján Baláž / C

VEGA 2/0086/16
Natural user interface based on RGB-D image processing algorithms and their application in biomedicine
Duration: 1.1.2016 / 31.12.2018
Responsible person: Zoltán Tomori / C

VEGA 2/0121/16
Superconducting and magnetocaloric ceramics

Duration: 1.1.2016 / 31.12.2018
Responsible person: Pavel Diko / C

VEGA 2/0132/16
Magnetic properties of selected 3d metal-oxides based multiferroics
Duration: 1.1.2016 / 31.12.2018
Responsible person: Mária Zentková / C

VEGA 2/0141/16
Interaction of magnetic fluids with electromagnetic field
Duration: 1.1.2016 / 31.12.2019
Responsible person: Milan Timko / C

VEGA 2/0149/16
Complementary study of superconductivity of selected materials
Duration: 1.1.2016 / 31.12.2019
Responsible person: Jozef Kačmarčík / C

VEGA 1/0164/16
Rapidly quenched amorphous and Heusler alloys with unique properties. Production and characterization
Duration: 1.1.2016 / 31.12.2018
Responsible person: Jozef Kováč / C

VEGA 2/0173/16
Rapidly quenched soft and hard magnetic composites for energy and sensor applications
Duration: 1.1.2016 / 31.12.2018
Responsible person: Ivan Škorvánek / C

VEGA 2/0174/16
Development of new procedures for the reconstruction and analysis of the data from the proton-proton collisions at the LHC
Duration: 1.1.2016 / 31.12.2019
Responsible person: Eduard Kladiva, Pavol Stríženec / C

VEGA 1/0377/16
Magnetization and relaxation processes in magnetic particles and composites
Duration: 1.1.2016 / 31.12.2019
Responsible person: Jozef Kováč / W

VEGA 2/0009/17 – significant results
Functional and structural insights into the phospholipid-protein interaction during oxidative Stress
Duration: 1.1.2017 / 31.12.2020
Responsible person: **Andrey Musatov / C**

VEGA 2/0015/17
The role of surface states in samarium hexaboride and other valence-fluctuating systems exhibiting metal-insulator transition
Duration: 1.1.2017 / 31.12.2020
Responsible person: Marianna Baťková / C

VEGA 2/0016/17
Macroscopic anisotropic composites based on liquid crystals and magnetic nanoparticles
Duration: 1.1.2017 / 31.12.2020
Responsible person: Natália Tomašovičová / C

VEGA 2/0065/17
Study of universal properties of diffusion proceses in turbulent environments
Duration: 1.1.2017 / 31.12.2020
Responsible person: Marián Jurčišin / C

VEGA 2/0132/17
Analysis of EUSO-SPB, Mini-EUSO and ground UV detectors experiments measurement
Duration: 1.1.2017 / 31.12.2019
Responsible person: Pavol Bobík / C

VEGA 2/0145/17 – significant results
Self-assembly of poly/peptides into amyloid aggregates – mechanism, inhibition and cytotoxicity Duration: 1.1.2017 / 31.12.2020
Responsible person: **Zuzana Gažová / C**

VEGA 2/0177/17
Mesoscale phenomena and structures in soft substances of polymeric and non-polymeric character
Duration: 1.1.2017 / 31.12.2019
Responsible person: Marián Sedlák / C

VEGA 2/0007/18
Investigation of nuclear material properties in the production of heavy quarks on nuclear targets
Duration: 1.1.2018 / 31.12.2021
Responsible person: Ján Nemčík / C

VEGA 2/0030/18
Supramolecular complexes of proteins – conformational transitions, stability and aggregation
Duration: 1.1.2018 / 31.12.2021
Responsible person: Diana Fedunová / C

VEGA 2/0039/18
Deformation of metastable amorphous and crystalline materials
Duration: 1.1.2018 / 31.12.2021
Responsible person: Kornel Csach / C

VEGA 2/0086/18 – significant results
Classical to quantum crossover in mechanical resonators
Duration: 1.1.2018 / 31.12.2021
Responsible person: **Marcel Človečko / C**

VEGA 2/0112/18
Systematic study of influence of local and nonlcal interactions on coexistence of quantum phases with different order parameters
Duration: 1.1.2018 / 31.12.2021
Responsible person: Pavol Farkašovský / C

VEGA 1/0113/18
Interactions of relativistic nuclei, eta-meson nuclei and spin physics
Duration: 1.1.2018 / 31.12.2020
Responsible person: Ján Mušinský / W

VEGA 2/0155/18
Cosmic energy particles from solar flares - multipoint observation from the Sun to Lomnický štít
Duration: 1.1.2018 / 31.12.2021
Responsible person: Radoslav Bučík, Šimon Mackovjak / C

VEGA 2/0009/19
Application of mathematical physics in various scalable systems
Duration: 1.1.2019 / 31.12.2022
Responsible person: Richard Pinčák / C

VEGA 2/0033/19
Functionalization of magnetic nanoparticles for cancer cell detection
Duration: 1.1.2019 / 31.12.2022
Responsible person: Martina Koneracká / C

VEGA 2/0044/19 – significant results
Alloyed REBCO bulk superconductors
Duration: 1.1.2019 / 31.12.2021
Responsible person: **Pavel Diko / C**

VEGA 1/0053/19
Influence of chemical composition on unique physical properties of modern functional materials
Duration: 1.1.2019 / 31.12.2021
Responsible person: Jozef Kováč / W

VEGA 2/0058/19
Study of thermodynamic properties of frustrated magnetic systems by exactly solvable models
Duration: 1.1.2019 / 31.12.2022
Responsible person: Eva Jurčišinová / C

VEGA 2/0083/19
Novel statistical and correlation methods in analysis of parametric models of surfaces and their distributions
Duration: 1.1.2019 / 31.12.2021
Responsible person: Jozef Marek / C

VEGA 2/0087/19
Detection of space plasma and energetic particles on board of space probes
Duration: 1.1.2019 / 31.12.2021
Responsible person: Ján Baláž / C

VEGA 2/0137/19
Orthorhombic multiferroic materials with strong magneto – electric coupling: effect of substitution in octahedral sites on magnetism and multiferroicity
Duration: 1.1.2019 / 31.12.2021
Responsible person: Marián Mihalik / C

VEGA 2/0171/19
Rapidly quenched metallic alloys and composites for magnetic and magnetocaloric applications
Duration: 1.1.2019 / 31.12.2022
Responsible person: Ivan Škorvánek / C

VEGA 1/0743/19
Ising superconductors and topologigal phases of the matter
Duration: 1.1.2019 / 31.12.2022
Responsible person: Pavol Szabó / W

VEGA 2/0011/20
Structure and dynamics of magnetic fluids in an electric field
Duration: 1.1.2020 / 31.12.2023

Responsible person: Michal Rajňák / C

VEGA 2/0032/20
Magnetic frustration and superconductivity in 2D and 3D borides
Duration: 1.1.2020 / 31.12.2023
Responsible person: Gabriel Pristáš / C

VEGA 2/0058/20
Research of non-trivial superconductivity on selected materials
Duration: 1.1.2020 / 31.12.2023
Responsible person: Jozef Kačmarčík / C

VEGA 2/0077/20
Cosmic rays in the heliosphere with terminating shock wave and heliospheric envelope
Duration: 1.1.2020 / 31.12.2023
Responsible person: Pavol Bobík / C

VEGA 1/0105/20
Theoretical study of multifunctional quantum low-dimensional magnetic materials
Duration: 1.1.2020 / 31.12.2023
Responsible person: Hana Čenčariková / W

VEGA 2/0115/20
Self-ordering of polymeric and non-polymeric materials in the liquid state on mesoscales
Duration: 1.1.2020 / 31.12.2022
Responsible person: Marián Sedlák / C

VEGA 1/0143/20
Magnetization processes of composites with surface-modified magnetic particles
Duration: 1.1.2020 / 31.12.2023
Responsible person: Jozef Kováč / W

VEGA 1/0333/20
Tear fluid and saliva in preventive, predictive and personalized medicine
Duration: 1.1.2020 / 31.12.2022
Responsible person: Natália Tomašovičová / C

VEGA 2/0039/21
Muons as a tool for exploring cave systems
Duration: 1.1.2021 / 31.12.2023
Responsible person: Marián Putiš / C

VEGA 2/0043/21
Self-organization processes in soft hybrid mixtures of liquid crystals and nanoparticles
Duration: 1.1.2021 / 31.12.2024
Responsible person: Natália Tomašovičová / C

VEGA 2/0081/21
Anomalous scaling in turbulent systems with symmetry breaking
Duration: 1.1.2021 / 31.12.2024
Responsible person: Marián Jurčišin / C

VEGA 2/0094/21
New insight into the role of hydrophobic interactions in formation and stability of proteins aggregates. Link to sxidative stress
Duration: 1.1.2021 / 31.12.2023
Responsible person: Andrey Musatov / C

VEGA 2/0176/21
Unraveling the early events of protein amyloid aggregation - from mechanism to therapy
Duration: 1.1.2021 / 31.12.2024
Responsible person: Zuzana Gažová / C

2.4.5. List of projects supported by EU Structural Funds

Start	Project title	Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2017	**Research and development of substances for the diagnosis of Alzheimer's disease (DIAGNAD)**	**ITMS2014+ 313011T553**	**1.1.2017 / 31.12.2019**	**73 808**	**C / Gažová**
	Modified (nano) textile materials for medical technologies (MODEX)	**ITMS2014+ 313011T548**	**1.1.2017 / 31.12.2019**	**147 585**	**C / Kopčanský**
2020	**MICROKELVIN - Quantum matters at very low temperatures**	**ITMS2014+ 313011W856**	**1.1.2020 / 30.6.2023**	**199 993**	**C / Skyba**
2021	**Development of biomodels to improve the evaluation of the efficacy of drugs and substances that have potential in the treatment of COVID-19 (BIOVID-19)**	**ITMS2014+ 313011AVG3**	**1.1.2021 / 30.6.2023**	**823 214**	**W / Koneracká**
	Nanoparticles for solving diagnostic-therapeutic problems with COVID-19 (NANOVIR)	**ITMS2014+ 313011AUW7**	**1.1.2021 / 30.6.2023**	**443 264**	**W / Závišová**

2.4.6. List of other projects funded from national resources

Bilateral projects funded by Slovak Academy of Sciences or APVV:

SK-UA Mechanical properties and failure peculiarities of the high-strength nanocrystalline metals, processed by the method of severe plastic deformation at temperatures 300 and 77 K. Duration: 1.1.2014 / 31.12.2016. Responsible person: **Kornel Csach** – C

SK-UA Hierarchy of phase transitions in cooperative systems with spin-interactions: Towards emergent time-scales for read-heads. Duration: 1.1.2014 / 31.12.2016. Responsible person: **Marián Mihalik** – C

SAV-AV ČR 15-19 Radiation fields near the Earth: possible connections with cosmic rays measured on the Earth's surface. Duration: 1.1.2015 / 31.12.2017. Responsible person: **Karel Kudela** – C
Total funding for the institute: 4 582 EUR

SK-HU-2013-0039 Elaboration and characterization of graphene layers with controlled nanoscale rippling. Duration: 1.1.2015 / 31.12.2016. Responsible person: **Pavol Szabó** – C
Total funding for the institute: 3 000 EUR

SK-HU-2013-0009 Magnetic properties of anisotropic composite nanosystems. Duration: 1.1.2015 / 31.12.2016. Responsible person: **Natália Tomašovičová** – C
Total funding for the institute: 2 800 EUR

SK-Argentina Spectroscopic, transport and thermodynamic properties of strongly-correlated electronic systems with competing orders. Duration: 1.1.2015 / 31.12.2017. Responsible person: **Zuzana Vargaeštoková** – C

SK-SRB-2013-0050 Magnetic nanocomposites for biomedical application. Duration: 1.1.2015 / 31.12.2016. Responsible person: **Mária Zentková** – C
Total funding for the institute: 4 860 EUR

SK-CZ Study of the protein amyloid aggregation in vitro and in cerebrospinal fluid. Duration: 13.7.2015 / 31.12.2020. Responsible person: **Zuzana Gažová** – C

SK-UA-2013-0027 Physical Mechanisms of the Low Temperature Plastic Deformation and Failure of New High Strength Multicomponent Amorphous and High-Entropy Alloys. Duration: 1.9.2015 / 31.12.2016. Responsible person: **Kornel Csach** – C
Total funding for the institute: 3 860 EUR

SK-UA-2013-0028 Relaxation and photoinduced phenomena in chalcogenide glasses. Duration: 1.9.2015 / 31.12.2016. Responsible person: **Karol Flachbart** – C
Total funding for the institute: 2 900 EUR

DAAD-SAV 57215995 Magnetic properties of tetraborides. Duration: 1.1.2016 / 31.12.2017. Responsible person: **Karol Flachbart** – C

SK-CN-2015-0023 The multitarget low molecular compounds from traditional Chinese herbs in treatment of Alzheimer´s disease. Duration: 1.1.2016 / 31.12.2017. Responsible person: **Zuzana Gažová** – C
Total funding for the institute: 8 000 EUR

SAV-CNR Amyloid aggregation of proteins in hybrid interfaces. Duration: 1.1.2016 / 31.12.2017. Responsible person: **Zuzana Gažová** – C

SAV-AV ČR 16-19 Space weather and atmospheric electricity. Duration: 1.1.2016 / 31.12.2017. Responsible person: **Ronald Langer** – C
Total funding for the institute: 3 065 EUR

SK-PT-2015-0030 Anisotropy of magnetoelectric coupling in rare-earth manganites. Duration: 1.1.2016 / 31.12.2017. Responsible person: **Marián Mihalik** – C
Total funding for the institute: 5 400 EUR

SK-PL Comprehensive studies of novel magnetic materials. Duration: 1.1.2016 / 1.1.2018. Responsible person: **Mária Zentková** – C

DS-2016-0046 Complex study of effects in low-dimensional quantum spin systems. Duration: 1.1.2017 / 31.12.2018. Responsible person: **Hana Čenčariková** – C
Total funding for the institute: 8 600 EUR

SK-UA Point-contact and tunneling spectroscopy of emergent iron-based superconductors. Duration: 1.1.2017 / 31.12.2019. Responsible person: **Peter Samuely** – C

SK-UA Synthesis and comparison of properties of Fe_3O_4 and $(La,Sr)MnO_3$ nanoparticles and magnetic fluids based on them. Duration: 1.1.2017 / 31.12.2019. Responsible person: **Milan Timko** – C

SK-UA Theoretical and experimental studies of orientational, magneto-optical and dielectric properties of composite liquid crystals filled with magnetic particles. Duration: 1.1.2017 / 31.12.2019. Responsible person: **Natália Tomašovičová** – C

SK-CN-2017-0009 RE211 nanosize pining centers in REBCO bulks formed by modified precursor powder process. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Pavel Diko** – C
Total fundig for the institute: 8 000 EUR

SK-AT-2017-0004 Superconductivity of boride thin films. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Karol Flachbart** – C
Total funding for the institute: 3 990 EUR

SK-CN-2017-0033 Discovery and Mechanism of Small Molecule Compounds from Traditional Chinese Medicine for treatment of Alzheimer 's Disease. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Zuzana Gažová** – C
Total funding for the institute: 8 000 EUR

SAV-18-02 Cosmic rays as observed at two high mountain observatories: BEO Moussala and Lomnicky Stit. Duration: 1.1.2018 / 31.12.2020. Responsible person: **Ronald Langer** – C

SAV-18-04 Atmospheric electricity and secondary cosmic radiation. Duration: 1.1.2018 / 31.12.2020. Responsible person: **Ronald Langer** – C

SAV-VAST Research on preparation and magnetic properties of Co/CoO core-shell nano-particles. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Ivan Škorvánek** – C

SK-TW 2017-0012 Study of orientation ordering and self-assembly in biopolymer and liquid crystal. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Katarína Šipošová** – C
Total funding for the institute: 8 000 EUR

SK-TW-2017-0002 Design of nanostructured bio-hybrid materials through self-assembly process. Duration: 1.1.2018 / 31.12.2019. Responsible person: **Natália Tomašovičová** – C
Total funding for the institute: 8 000 EUR

DAAD-SAV 57452699 Metallic geometrically frustrated systems. Duration: 1.1.2019 / 31.12.2020. Responsible person: **Slavomír Gabáni** – C

SAV-MAV Investigation of new ferromagnetic composites. Duration: 1.1.2019 / 30.06.2022. Responsible person: **Jozef Kováč** – C

SAV-MAV Ordering and self-organization of magnetic nanoparticles in liquid crystals. Duration: 1.1.2019 / 30.06.2022. Responsible person: **Veronika Lacková** – C

SAV-MAV Investigation of graphene covered superconducting nanostructures by scanning tunneling microscopy. Duration: 1.1.2019 / 30.06.2022. Responsible person: **Pavol Szabó** – C

SAV-MAV Elastic micro-tools for optical manipulation of biological objects. Duration: 1.1.2019 / 30.06.2022. Responsible person: **Zoltán Tomori** – C

SK-SRB-18-0055 Complementary analytic methods for the determination of the biodistribution of the magnetic nanoparticles. Duration: 15.2.2019 / 31.12.2021. Responsible person: **Martina Koneracká** – C
Total funding for the institute: 7 050 EUR

SK-SRB-18-0066 Magnetic nanocomposites for biomedicine. Duration: 15.2.2019 / 31.12.2021. Responsible person: **Mária Zentková** – C
Total funding for the institute: 7 050 EUR

SAV-PAV Multifunctional magnetic materials - research into structure and physical properties. Duration: 19.2.2019 / 31.12.2022. Responsible person: **Mária Zentková** – C

SAV-VAST Preparation and study of structural and magnetic properties of core/shell CoFe2O4/Fe3O4 nanoparticles for advanced magnetic hyperthermia. Duration: 1.1.2020 / 31.12.2022. Responsible person: **Ivan Škorvánek** – C

DS-FR-19-0052 Design and preparation of multifunctional magnetic nanoparticles for the cancer cell detection. Duration: 1.3.2020 / 31.12.2022. Responsible person: **Vlasta Závišová** – C
Total funding for the institute: 18 750 EUR

SAV-NASU Effect of alloying additions of carbon on low temperature physical mechanisms of plastic deformation, failure and fracture toughness of high-strength high entropy alloys in different states. Duration: 1.4.2020 / 31.12.2022. Responsible person: **Kornel Csach** – C

BAS-SAS-21-02 Stability and aggregation of globular proteins in the presence of biocompatible ionic liquids. Duration: 1.1.2021 / 31.12.2022. Responsible person: **Diana Fedunová** – C
Total funding for the institute: 4 000 EUR

Mob-Open-20-04 Superconducting properties of boride thin films. Duration: 1.1.2021 / 31.12.2022. Responsible person: **Karol Flachbart** – C
Total funding for the institute: 6 000 EUR

DAAD-SAV 57561069 Tuning of frustrated metallic quantum magnets. Duration: 1.1.2021 / 31.12.2022. Responsible person: **Slavomír Gabáni** – C

SAV-AV ČR-21-01 Atmospheric electric field and dynamics of charged particles and secondary cosmic rays in high mountains. Duration: 1.1.2021 / 31.12.2022. Responsible person: **Ronald Langer** – C
Total funding for the institute: 3 000 EUR

2.4.7. List of projects funded from private funds

2.4.8. List of projects funded from other competitive funds

2.5. PhD studies and educational activities

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

1. **Theoretical physics** – Faculty of Sciences, Pavol Jozef Safarik University, Košice (since 2004), SAS PhD fellowship

2. **Condensed matter physics** – Faculty of Sciences, Pavol Jozef Safarik University, Košice (since 2004), SAS PhD fellowship

3. **Nuclear and subnuclear physics** – Faculty of Sciences, Pavol Jozef Safarik University, Košice (since 2004), SAS PhD fellowship

4. **Materials** – Faculty of Metallurgy, Technical University, Košice (since 2009), SAS PhD fellowship

5. **Biophysics** – Faculty of Sciences, Pavol Jozef Safarik University, Košice (since 2016), SAS PhD fellowship

6. **Physical engineering of advanced materials** – Faculty of Electrical Engineering and Informatics, Technical University, Košice (since 2016), SAS PhD fellowship

7. **Advanced materials** – Faculty of Sciences, Pavol Jozef Safarik University, Košice (since 2019), SAS PhD fellowship

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

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors	49			49			49			48			46			46		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	unumber, end of yea	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	18	2	1	17	8	0	15	3	1	15	2	2	13	4	1	16	3	0
from which foreign citizens	0	0	0	1	0	0	0	0	0	1	0	0	2	0	0	4	0	0
External	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Other supervised by the research employees of the institute	8	0	0	8	0	0	8	0	0	1	0	0	8	0	0	1	0	0

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

Number of defended PhD students = 23 from which:

Continue at IEP SAS:	**Period of study:**	**Name of Department:**
Monika Radušovská	9/2010 - 8/2016	Department of Material Physics
Veronika Gdovinová	9/2013 - 8/2017	Department of Magnetism
Liudmila Vojtková	9/2013 - 8/2017	Department of Material Physics
František Andrejka	9/2014 - 8/2018	Dept. Appl. Magn. and Nanomaterials
Petra Hajdová	9/2015 - 8/2019	Department of Material Physics
Matúš Orendáč	9/2015 - 8/2019	Centre of Low Temperature Physics
Miroslav Gančár	9/2016 - 8/2020	Department of Biophysics
Branislav Kunca	9/2016 - 8/2020	Dept. Appl. Magn. and Nanomaterials
Ľubomíra Regeciová	9/2017 - 8/2021	Department of Theoretical Physics
Katarína Zakuťanská	9/2017 - 8/2021	Department of Magnetism

Continued at SAS/University:		**Name of Institute/University:**
Zuzana Molčanová	9/2013 - 8/2017	Institute of Materials Research SAS
Richard Jacko	9/2013 - 8/2020	Technical University, Košice
Miroslav Marcin	9/2016 - 8/2020	P.J. Safarik University, Košice
Martin Menkyna	9/2016 - 8/2020	P.J. Safarik University, Košice
Ondrej Šofranko	9/2017 - 8/2021	P.J. Safarik University, Košice

Continued as postdocs abroad:		**Name of Institute/University:**
Zuzana Medvecká	9/2013 - 8/2017	MPI Dresden, Germany
František Vavrek	9/2013 - 8/2017	Heyrovský IPCh CAS, Czech Republic

Continued in industry and school sector:

Mária Huráková	9/2012 - 8/2016	industry - US Steel Košice
Marek Antoňák	9/2009 - 5/2017	school sector
Michal Dančo	9/2011 - 8/2017	IT sector
Veronika Hašková	9/2013 - 8/2017	IT sector
Jozefína Majorošová	9/2012 - 8/2018	school sector
Renáta Verbová	9/2013 - 8/2018	chemical industry

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	465	502	304	517	500	474
Practicum courses (hours/year)*	197	69	76	99	169	201
Supervised diploma and bachelor thesis (in total)	28	36	38	26	15	10
Members in PhD committees (in total)	9	6	9	7	8	9
Members in DrSc. committees (in total)	2	3	4	1	4	2
Members in university/faculty councils (in total)	6	6	6	2	1	2
Members in habilitation/inauguration committees (in total)	2	3	3	2	2	2

Number of reviewing PhD and habilitation thesis:

9 (2016), 8 (2017), 9 (2018), 8 (2019), 8 (2020), 27 (2021)

2.5.5. List of published university textbooks

GABÁNI, Slavomír - MIHALIK, Marián - PRISTÁŠ, Gabriel - ZENTKOVÁ, Mária. Fyzika a technika vysokých tlakov II. Košice: Ústav experimentálnej fyziky SAV, 2016. 99 s. ISBN 978-80-89656-14-1, Type: BCI

2.5.6. Number of published academic course books

2.5.7. List of joint research laboratories/facilities with universities

Laboratory of Magnetism - Department of Magnetism IEP SAS with the Faculty of Science, P. J. Šafárik University, Košice. This long term collaboration is focused on the study of microstructure and magnetic properties of nanostructured and composite soft magnetic materials as well as various systems of magnetic nanoparticles

Centre of Low Temperature Physics (CLTP) - joint low temperature laboratories of the Department of Low Temperature Physics IEP SAS and Faculty of Science, P. J. Šafárik University form the CLTP. The Centre uses common low temperature infrastructure (including 4He liqufier) and common experimental equipments. The Centre organizes periodical seminars about low temperature physics.

Faculty of Metallurgy Technical University Košice - joint laboratory - The collaboration is focused on the pedagogical area and exploitation of experimental facilities.

Faculty of Electrotechnics, University of Žilina - joint laboratory. The joint research laboratories develop the cooperation in area the study of acoustic, magnetic and dielectric

properties of magnetic fluids and ferronematics (complex system of liquid crystal and magnetic nanoparticles).

Faculty of Aeronautics Technical University Košice - joint laboratory. This agreement between our institution is devoted to the cooperation in pedagogical and research areas mainly in study of dielectric and hyperthermic properties of systems containing the magnetic nanoparticles.

Faculty of Pharmacy Comenius University Bratislava – joint laboratory, allowing study of the amyloid aggregation of proteins and their interference with small molecules.

PROMATECH - the aims of the project is creation and operation of Slovak research centre at the highest level as an integrated and interdisciplinary center, which will conduct research of materials and technologies for current and future applications, generating scientific research results with high innovation potential and short application time to industrial practice. The main project partner is the Slovak Academy of Sciences, other partners are the Institute of Materials Research SAS, Institute of Experimental Physics SAS, Institute of Geotechnics SAS, Institute of Materials and Machine Mechanics SAS, University of Pavol Jozef Šafárik in Košice and Technical University in Košice.

2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

Since the last evaluation, regular PhD seminars are organized, where every student presents recent results and other activity realized during last academic year.

Since 2016, three new accredited programmes were introduced: Advanced materials, Biophysics and Physical engineering of advanced materials, to increase interest in the PhD study and offer high quality supervisors.

Since 2020, new internal doctoral study assurance system has been approved by Scientific council of IEP SAS to increase quality of PhD study and reduce number of quitted students.

Since 2019, SAS Presidium approves Call for applications under the Grant Programme for SAS PhD students – Doktogrant – every year. The Grant programme for SAS PhD students is the SAS activity with intend to support scientific projects for students of a daily form of PhD study carried out within SAS organizations. The aim is to financially support high-quality project proposals, which will be implemented during PhD studies as a coherent part of projects and which can be realized within one year. A number of PhD student from IEP SAS applied for this project and 4 of them won the project:

Doktogrant – SAS grants for PhD students:

Start	Project title	Project number	Duration	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2020	Influence of nanoparticle size on ac-susceptibility of ferronematics	APP0049	1.1.2020 / 31.12.2021	2 000	C / Zakuťanská
	Ionic liquids as modulators of amyloid aggregation	APP0004	1.1.2020 / 31.12.2020	2 000	C / Vaník

2021	**Impact of magnetic and electric field on structure of magnetic fluids**	**APP0140**	**1.1.2021 / 31.12.2022**	**2 000**	**C / Karpets**
	Study of anti-oxidant and enhanced anti-amyloid activity of cerium nanoparticles for biomedical applications	**APP0164**	**1.1.2021 / 31.12.2021**	**2 000**	**C / Garčárová**

2.6. Societal impact

2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study.

Development of radiation hardened chips for the ATLAS experiment at CERN.

The development of sophisticated equipment for the high energy and particle physics experiments does not lead to applications directly usable in everyday life outside of the field of science. The research facilities in large centres like CERN have always required cutting edge technologies and a large number of individual components (be it electronics or detectors) that were often not directly available on the market. This in turn stimulated the industry to set up mass production of those specific goods, often leading to drop of production costs and made initially highly specialized technologies available for applications with direct impact on the society (e.g. radiation detection for the healthcare or law enforcement, radiation hard equipment for the nuclear energy sector and so on). The process of turning advanced technologies for the elementary particle physics, which is a field of pure science, into practical products may take years or even decades.

The ATLAS experiment at CERN is scheduled for a major upgrade of all its subsystems in order to raise its scientific potential, as well as to help the detector cope with increasing luminosity (and higher collision rate) of not only the current design of the LHC collider but also of the planned next step in its development known as HL-LHC (HL stands for High Luminosity). All these changes are necessary to gain insight into very rare physical processes which might unveil physics beyond the Standard Model, one of the Holy Grails of the present-day particle physics.

One of the ATLAS upgrade projects was the development of the Analogue Digital Converter (ADC) chip set for the new trigger electronics of the Liquid Argon (LAr) calorimeter readout. In the design requirements called for a radiation hard dual-channel 12 bit 40 MHz pipeline ADC with the power consumption being less than 145 mW/channel. Since no commercially produced chips could fulfil requirements for speed, precision, low power and radiation hardness, a custom design with commercial manufacture of the prototypes and the final product was chosen. For the whole ATLAS experiment about 10000 ADC chips will be need. The project was financed and organized by the Nevis Laboratories, Columbia University, Irwington NY, USA, with a designer of critical parts J. Bán from IEP SAS, Košice. The project started in 2009 and the IEP SAS participation ended in 2017.

In order to reach the main goal and always to use the cutting-edge technology a development roadmap with roughly annual submissions of increasingly complex designs was proposed. During the evaluation period J. Bán developed a serializer chip for sending ADC data via optical link. The chip is to be used in a LTDB trigger module. The chip, based 130 nm technology, contains 2 channels of full serialization logic and scrambler working at 4.8 GHz. After the chip passed all tests the design was submitted for manufacturing. This chip will find its place in the LAr calorimeter trigger built for the ALTLAS Phase I upgrade. The next step on the roadmap was beginning of the development of basic building blocks for the ADC in 65 nm technology for the LAr calorimetry to be built for the ATLAS Phase II upgrade, which will take place about a decade after the Phase I.

The scale of the experimental installation and the number of individual units needed will demand a true mass production, which might have immediate positive effect on the producer and promote further development of technologies used in the production of the fast, reliable and radiation hard electronics, that may find its way into laboratory equipment for fields of human activity, where intensive radiation plays dominant part.

2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))

Ján Baláž
member of the National Committee of COSPAR – Committee on Space Research (http://nccospar.saske.sk) - preparations of national COSPAR biennal reports 2014-2015, 2016-2017, 2018-2019, 2020-2021

member of Scientific board of the Commision for Space Activities at the Slovak Ministry of Education, Science, Research and Sport.

member of Commision for accreditation of study programme “Space engineering” at Slovak Technical University, Bratislava

Dušan Bruncko
member of Scientific Board / International Advisory Body for the project LM2015068, Czech Republic, 2016

evaluation of the projects LTT17002, LTT17003 and LTV17012, Czech Republic 2016

member of Scientific Board / International Advisory Body for the project LG15047, Czech Republic, 2017

evaluation of projects INDIGO LG15052, tLGI15047, LTAUSA17 and LTT18017, Czech Republic, 2017

evaluation of the project MOBILITY France 7AMB18, 2017

Karol Flachbart
member of commission for the evaluation of Institutes of the Czech Aacademy of Sciences, 2021

Karel Kudela
chairman of the National Committee of COSPAR

member of UN Committee of COPUOS (Commission for Peaceful Use of Outer Space)

Peter Kopčanský
member of evaluation committees of scientific proposals for ILL Grenoble (2015-2019), and JINR Dubna (2015-15. 6. 2022)

member of International steering committee of Magnetic Fluids Society (from 2007 till now)

member of commission fot the evaluation of the Institute of Electron Physics of National Academy of Science Ukraine, 2019

evaluation of the projects for DFG Germany, 2019,

evaluation of the projects for NSC Poland (National Science Centre), 2020

Peter Samuely
participated in the work of the Commission of the Ministry of Education, Science, Research and Sport for a preparation of the Slovak Act on public research institutions, 2020

participated in the work of the Commission of the Ministry of Education, Science, Research and Sport for a preparation of the Regular evaluation of Slovak public institutions performing research, development, arts and other creative activities (2020-2021)

member of the Commission of the Ministry of Education, Science, Research and Sport for acreditation of the all Slovak research performing organizations - evaluation of more than 300 private, NGO, public and state organizations (2016-2021)

chairman of the Council of Natural Sciences at the Slovak Agency for Research and Development (APVV) - reported on some 100 projects (2016-2021)

chairman of the jury for International prize of the Slovak Academy of Sciences (2016-2021)

member of the jury for the Scientist of the year in Slovakia award (2016-2021)

Peter Skyba
member of C5 - commission of the IUPAP (2014-2017, 2017-2021)

reviewer and member of a PhD commissions at Aalto University (Finland), Lancaster University (UK), Charles University Prague (Czech Republic)

Pavol Stríženec
evaluation of the projects LTT18001, LTT18002, LTT18004, LTAUSA18051 and LTAUSA18120, Czech Republic 2018

Ivan Škorvánek
Evaluation of the projects for Horizon Europe Programme (MSCA Postdoctoral Fellowships call), 2021

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

Thermal-vacuum qualification test and vibration qualification test of space borne instrumentation (SK-Cube nanosatellite) for SOSA (Slovak Organisation for Space Activities), 2015
Contract value: for free

External analysis of PVC latex samples - measurements of the size distribution of PVC emulsion types for Fortischem a. s. Nováky. Development of new dyes and improvement of properties of produced paints and coatings for various industrial applications, 2016, 2017, 2019
Contract value (summary): 4 530,- EUR

Thermal-vacuum qualification test of space borne instrumentation (GRBAlpha nanosatellite) for Technical University Kosice, 2020
Contract value: 960,- EUR

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

Patents and patent applications [1-4] are based on the concept of mesoscale solubility. The invention represents a new method of measuring the content of hydrophobic substances (contaminants) in water soluble compounds [1-3]. The measurement method is based on the finding that hydrophobic contaminants, after mixing the compound with water, segregate into discrete, stable mesoscale structures (nanoparticles/nanodroplets) whose number concentration, size and density correlate with the content of contaminants in the test compound, which is subsequently quantified by static laser light scattering method. Patent application [4] deals with a new method of purification of organic water-soluble substances from hydrophobic contaminants to high degrees of purity of substances (below 1 ppm). Subsequent research performed after filing patent applications [1-3] revealed that the resulting nanoparticles/nanodroplets are sufficiently mechanically strong and stable in shape to be subsequently eliminated by nanofiltration without the need to add any additives as nanoparticle/nanodroplet stabilizers and subsequent contamination of the mixture with these additives. Both patented methods are relatively simple, inexpensive, and fast.

[1] SEDLÁK, Marián – RAK, Dmytro: Measurement of the alkane content in alcohols by the method of nanoseggregation in aqueous solutions. Industrial Property Office of the Slovak Republic, patent number 288560, 2018.

[2] SEDLÁK, Marián – RAK, Dmytro: Measurement of the content of hydrophobic compounds in water-Miscible Organic Liquids. Industrial Property Office of the Slovak Republic, patent number 288766, 2020.

[3] SEDLÁK, Marián – RAK, Dmytro: A Method for Determination of Content of Hydrophobic Compounds in Water-Miscible Organic Liquids, European Patent Office, application EP15710288.0, 2016.

[4] SEDLÁK, Marián – RAK, Dmytro: A method for purification of water soluble compounds from hydrophobic contaminants. European Patent Office, application EP17160213.9, 2017.

Traditional interactive analysis of images acquired by confocal microscope is based on user's observation of selected image on the screen followed by an interaction (e.g. by mouse) which is a time - consuming and monotonous activity. The invention exploits an eye-tracking camera combined with proper visualization software to identify object of interest by user's gaze, which is much more efficient [6].

[6] TOMORI, Zoltan: Method of interactive quantification of digitized 3D objects using an eye-tracking camera. US patent No.10.922.899 B2, 2021.

Dielectric materials doped with magnetic nanoparticles are of great interest for electrical engineering applications. Their dielectric response depends on an external magnetic field. The magneto-dielectric response is commonly tested by measuring the dielectric permittivity of a dielectric placed between permanent magnets or in an electromagnet. The conventional electromagnets are often robust and energy consuming, while the permanent magnets provide just discrete values of the magnetic field intensity. However, testing of magneto-dielectric response of dielectric nanofluids or thin layers of nanodielectrics often requires small, portable and energy efficient magnetic generators providing a tunable and homogenous magnetic field. For this purpose, we (M. Rajňák from IEP SAS and B. Dolník from FEEI TUKE) have developed a device consisting of a specifically designed electromagnet with a gap as an experimental area, where the magneto-dielectric response of the materials can be effectively tested [7]. Together with a thin plate capacitor connected to an impedance analyzer, the developed setup provides the following advantages: measuring of influence of the magnetic field without the need of a special laboratory; the possibility of placing the device in a special atmosphere or a cryogenic liquid; the possibility of measuring

the effect of magnetic field on living organisms; the need for a significantly smaller volume of the tested material; the generated magnetic field acting on an investigated sample is homogenous; variability of the generated magnetic field in the measuring place; low acquisition costs; economical operation of the device. The energy efficient device can be used for example for testing of the influence of magnetic field on dielectric response of a thin layer of magnetic fluid or formation of structured nanocomposite polymer films.

[7] RAJŇÁK, Michal – DOLNÍK, Bystrík: Energy-efficient device for measuring magneto-dielectric response. Industrial Property Office of the Slovak Republic, application PP 50062, 2021.

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

2.7. Popularisation of Science (outreach activities)

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

Vedecký brloh **(Science lair)** (since 2013) for kids is directly supervised by our institute and as it is specifically focused to kids its philosophy is based exclusively on hands on experiments and in general education mediated interactively with fun and adventure (https://www.vedeckybrloh.sk). Science lair is visited by the whole families with kids, school kids with teachers and by groups of homeschooled children, gifted kids as well as kids with some kind of disorder, namely kids with Asperger syndrome. On site activities are accompanied by blogs where the kids could find digest with description of realized experiments. In 2019, the coordinator of the project Mária Zentková was awarded with the Science and Technology Prize from Ministry of Educations in the category Popularizer.

Vedecký večerníček **(Science bedtime stories)** (since 2021) – podcast about science for kids and young people organized by Science Lairs organization and supported by SAS, in which scientists answer curious question of pupils from primary schools. There were several episodes also with scientists from IEP SAS: On space missions (Ján Baláž), About superconductivity (Jozef Kačmarčík), About Alzheimer´s disease (Zuzana Bednáriková).

Researchers night – is the biggest scientific popularization action in EU and Slovakia since 2006. The main coordinator of the scientific program of the Košice action is Pavol Szabó, the member of Committee for popularization in Slovakia. Our institution presents 5 – 10 scientific/show experiments and 2-3 popularization talks yearly. The festival in Košice is organized in a Shopping Centre Optima, where the average number of visitors is above 15 000. In 2020 and 2021, Research night has been realized in on-line form.

Space::Lab – is an initiative of Department of Space Physics coordinated by Šimon Mackovjak (https://space-lab.sk/en) for people who can engage in space science and space engineering and work side by side with top experts. The persons concerned become a part of SPACE::LAB by attending regular SPACE::TALK meetups (unique interactive talks by top Slovak experts in the field) or entering the SPACE::PROJECT competition for high school and university students to show their talent and get a scholarship for your project. Every year, the summer school for SPACE::PROJECT participants is organized, which includes both theoretical lectures and practical hands-on sessions. In 2020, the coordinator of this project Š. Mackovjak has been awarded with the Prize of Slovak Academy of Sciences for Popularization.

TUKE Space Forum – project supported by European Space Agency (ESA), which is organized by Pavol Bobík and aimed to expand knowledge about space research and related technologies (https://spaceforum.sk/en/tuke-space-forum/). The goal is to bring the most interesting space research projects through talks of international experts who work on them.

EXPO Dubai 2020 – IEP SAS was a part of the thematic „Space week“ during the world fair Expo 2020 in Dubai. In rotating exposition of the Slovak pavilion, digital exhibit called „Space Lab Slovakia“ presented our Space missions, Space research and Digital transformation of the research. In addition to the digital exhibit, IEP SAS was also represented during the scientific program prepared by the Ministry of Education, Science, Research and Sport of the Slovak Republic. Šimon Mackovjak has presented a talk entitled „*Towards autonomous space safety*“, which builds on previous educational activities (GlobalLogic Webinar, SPACE :: LAB Summer School). The digital exhibition of IEP SAS was created in cooperation with the design team of GlobalLogic Slovakia. Emphasis was given to visually match the exhibition with the design of the Slovak pavilion. Therefore, a modern, minimalist style was chosen with a focus on delivering a message.

Magnetic and Materials Day – during Science and Technology week in 2019, the public day was organized by Institute of Experimental Physics, Institute of Materials Research and Science Lair for students in the morning and others in the afternoon. This day started with lecture Hommage Nikola Tesla (J. Tejiščák and M. Zentková) and continued with excursions of laboratories: High magnetic fields (M. Rajňák), Magnetic hyperthermy (M. Molčan), Magnetic liquids (K. Pavlovičová, V. Lacková) and Technological laboratory (M. Mihálik).

IEP SAS in ESA space missions. The Institute of Experimental Physics has more than fifty years of experience in the preparation of scientific space missions, especially within the Russian “Interkosmos” space flight program. Despite the fact that Slovakia is still not a full member of ESA, the institute significantly contributed to the preparation of several missions, this is thanks to its rich international cooperation with scientists from ESA member countries (J. Baláž, Review article in Československý časopis pro fyziku 71, 4/2021, p. 282).

Time travel and parallel universes. In 2021, two interesting and surprising results were achieved by theoretical physicist Richard Pinčák, with the potential to change common paradigms in cosmology and particle physics. The first result (Interview in TV Markíza, The New SAS) shows that by introducing a special type of space containing negative dimensions, seemingly unrelated phenomena can be explained, such as strings in particle physics, superposition of particles, dark matter in cosmology or paradoxes associated with traveling through a wormhole (main theme articles in journals Quark and Kozmos). Also an important result is the definition of the formation of the string itself as a fundamental unit of matter by the interaction between positive and negative dimensions. The second result shows the discrete nature of space and time (The News SAS) and also the possibility of how to prove it.

Human Tears. In 2019, the exhibition "Human Tear as Art" was opened to the public in the premises of the Kasárne/Kulturpark in Košice. The pilot scientific and artistic project aimed to present the results of several years of research by scientists from the Faculty of Medicine and the Faculty of Science of UPJŠ and the IEP SAS in Košice, which pointed to the interesting diagnostic potential of original images of human tear fluid in various diseases. A total of 27 images were exhibited, representing interesting features and patterns that create the tears of sick people imaged using an atomic force microscope in nanometers. N. Tomašovičová and K. Zakuťanská won the Rector's Award of UPJŠ in Košice for a significant media act and media response to the organization of this exhibition.

On the occasion of the **50th anniversary** of the founding of the **IEP SAS**, brochures were produced in Slovak (brochure in SK) as well as in English (brochure in EN) to promote the institute at home and abroad, especially when presenting guests who visit the institute. All heads of departments and the scientific secretary of the institute participated in the preparation of the brochures in cooperation with a graphic designer.

International Masterclasses. Each year more than 13.000 high school students in 60 countries come to one of about 225 nearby universities or research centres for one day in order to unravel the mysteries of particle physics. Lectures from active scientists give insight to the topics and methods of basic research at the fundaments of matter and forces, enabling the students to perform measurements of real data from particle physics experiments themselves. At the end of each day, like in an international research collaboration, the participants join in a video conference for discussion and combination of their results. IEP SAS as member of CERN participate on this acitivity every year in cooperation with colleagues from FS UPJŠ.

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	15	25	12	18	32	18	120
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	6	9	19	22	14	10	80
Public popularisation lectures	15	28	22	22	6	9	102

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	9	51	3	8	17	27	16
Female	0	31	0	2	0	17	14

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	6.0	3.4	6.0	4.8	9.0	4.4	10.0	4.5	9.0	6.0	3.0	3.0	6.0	5.5	14.0	10.3	7.0	4.0
Female	3.0	0.3	6.0	2.0	6.0	3.8	2.0	1.0	9.0	5.5	4.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0

A – number

B – FTE

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

2.8.2.2. Stefan Schwarz fellowships

Anežko Hashim	1.5.2011 - 30.4.2016	Department of Magnetism
Marián Putiš	1.1.2013 - 31.12.2016	Department of Space Physics
Peter Kaliňák	1.5.2013 - 30.4.2017	Department of Subnuclear Physics
Daniela Volochová	1.5.2013 - 30.4.2017	Department of Materials Physics
Katarína Šipošová	1.1.2014 - 31.12.2017	Department of Biophysics
Matúš Molčan	1.5.2015 - 30.4.2019	Department of Magnetism
Martina Kubovčíková	1.1.2015 - 31.12.2018	Department of Magnetism
Michal Rajňák	7.6.2016 - 07.06.2020	Department of Magnetism
Zuzana Bednáriková	1.1.2017 - 31.12.2022	Department of Biophysics
Veronika Lacková	1.6.2019 - 31.5.2022	Department of Magnetism
Lucia Balejčíková	1.10.2020 - 13.6.2020	Department of Magnetism
Iryna Khmara	1.6.2020 - 21.5.2022	Department of Magnetism
Matúš Orendáč	1.6.2020 - 31.5.2023	Centre of Low Temperature Physics
Monika Radušovská	1.6.2020 - 31.5.2023	Department of Materials Physics

2.8.2.3. Postdoctoral positions from other resources (specify)

2016
Dr. Piotr Gebara
Institute of Physics, Częstochowa University of Technology, Częstochowa, Poland
3 months postdoc stay at DAMN supported by SAIA

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding *(max. 2 pages)*

The experimental infrastructure of the **Department of Subnuclear Physics** is located at the international research centre CERN, Geneva, Switzerland. IEP SAS contributed to the building and upgrades of two major experiments: ALICE and ATLAS. The integral part of the experiments at CERN LHC is a GRID computing farm for massive computing and data storage. At the end of 2021 it provided 1181 CPU cores and 2.69 PB of disk storage. Computing resources undergo an upgrade every year in order to increase the number of CPU's, disk space and network bandwidth. In 2020 a fraction of the GRID farm was dedicated to the project **Folding@Home** (https://foldingathome.org). One of the researched subjects was a search for protein structures that might help to fight the SARS-Cov-2 virus.

Centre of Low Temperature Physics as member of the European Microkelvin Platform supported by several national projects (National Research Platform on Quantum Technologies, APVV, VEGA) developed new cutting edge experimental techniques as: an ultra sensitive microcalorimetry for very low temperatures, spin-polarized scanning tunnelling microscopy/spectroscopy, quasiparticle interference QPI STM spectroscopy, measurement of resistivity up to 10 GPa and quantum Hall effect down to very low tempereatures, rotating calorimeter for angular dependence of magnetocaloric effect, sensing detection of hydrogen (less than 1 ppm) in liquid helium, field independent thermometers below 1 K based on quartz tunning forks, etc. This opens new possibilities for wider range of users not only in basic research but also in transfer of knowledge to applications in the coming era of quantum technologies.

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

3. *Implementation of the recommendations from the previous evaluation period*

Comments and specific recommendations for further improvements of the IEP SAS of the previous assessment can be summarized as folow:

I.) *Increase focus on the strategic actions/changes/improvement by setting up measurable goals and milestones*.

Research in condensed matter physics, biophysics as well as in particle physics were focused on topics (quantum-, nano-, bio-, green-, space- physics and technology) what led to new cooperations covered by major projects (EMP, NATO, ESA, COST, etc.), the increase of number and quality of publications (Nature Index and Q1), citations and has brought a number of new patents and applications:

Scientific outputs	CC publications per year	SCI citations per year	Cit / Publ	Patents IP / SK
2016-2021	251	4 314	17.19	11 / 3
2012-2015	240	3 436	14.32	2 / 3
Present outputs normalized to previous period 2016-2021 / 2012-2015	**1.05**	**1.25**	**1.20**	**5.5 / 1**

II.) *Set up an international Advisory body*.

The first, in 2017, “Action plan” was created and subsequently approved by the Scientific council of IEP SAS, which also includes the implementation of the recommendations of the evaluation “Meta-panel” for the next accreditation period. Following the created Action plan, the **International Advisory Board (IAB) was approved** in September 22, 2017 by Scientific council of IEP SAS. The first IAB meeting at the IEP SAS took place in November 5-6, 2018, when Biennal report of period 2016-2017 was evaluated. The aim of the meeting of internationally recognized experts was to get acquainted with the research at the institute, with its organizational structure and plans for the following period. Not only the strengths but also the weaknesses of the institute and its functioning were identified. After the meeting, the institute received a written statement and recommendations of IAB members in order to improve the position of the institute not only at the national but also at the international level. IAB members were suggested to initiate - partial organizational changes and support for the creation of research groups with a high level of autonomy (merging groups with very similar research), which will be managed by group leaders and coordinated by department heads; in order to create new dynamic scientific teams. These teams should be created with regard to research, personnel capacities of individuals and the ability to purposefully re / organize in the preparation and solution of projects of the Ministry of Education of the Slovak Republic (state programs, SF projects), VEGA, APVV, EU framework programs, and cooperation with domestic and foreign partners. This suggestion has been fulfilled.
Next IAB meeting for evaluation of Triennal report of period 2018-2020 was planned in autumn 2021, but has been cancelled due to pandemics Covid-19. We have obtained the Referee reports from all members of IAB.

III.) *Continue and increase the stimulation/incentives for high quality publications in internationally leading journals*.

High quality publications and research outputs are awarded every year by Scientific council of IEP SAS as well as Presidium SAS and financially supported. Authors of high-quality publications are gaining awareness, reputation and popularity among scientists and the public. Usually they will receive invited lectures.

The following Nature Index publications were published in period 2017-2021:

1) G. Zhang, T. Samuely, H. Du, Z. Xu, L. Liu, O. Onufriienko, P.W. May, J. Vanacken, P. Szabó, J. Kačmarčík, H. Yuan, P. Samuely, R.E. Dunin-Borkowski, J. Hofkens, V.V. Moshchalkov: *Bosonic confinement and coherence in cisordered nanodiamond Arrays*, ACS Nano 11, 11746 (2017)
2) G. Zhang, T. Samuely, Z. Xu, J.K. Jochum, A. Volodin, S. Zhou, J. Vanacken, P.W. May, O. Onufriienko, J. Kacmarcík, J. A. Steele, J. Li, J. Vanacken, J. Vacík, P. Szabó, H. Yuan, M.B. J. Roeffaers, D. Cerbu, P. Samuely, J. Hofkens, V.V. Moshchalkov: *Superconducting ferromagnetic nanodiamond*, ACS Nano 11, 5358 (2017)
3) ALICE (P. Kaliňák, I. Králik, M. Krivda, J. Mušinský, L. Šándor et al.): *Enhanced production of multi-strange hadrons in high-multiplicity proton-proton collisions*, Nature Physics 13, 535-539 (2017)
4) A.H.A. Hassan, R.J.H. Morris, O.A. Mironov, S. Gabáni, A. Dobbie, D.R. Leadley: *An origin behind Rashba spin splitting within inverted doped sGe heterostructures*, Applied Physic Letters 110, 042405 (2017)
5) P. Farkašovský: *Formation and condensation of excitonic bound states in the generalized Falicov-Kimball model*, Physical Review B 95, 045101 (2017)
6) J. Kačmarčík, I. Vinograd, B. Michon, A. Rydh, A. Demuer, R. Zhou, H. Mayaffre, R. Liang, W.N. Hardy, D.A. Bonn, N. Doiron-Leyraud, L. Taillefer, M.-H. Julien, C. Marcenat, T. Klein: *Unusual interplay between superconductivity and field-induced charge order in* $YBa_2Cu_3O_y$, Physical Review Letters 121, 167002 (2018)
7) P. Hlawenka, K. Siemensmeyer, E. Weschke, A. Varykhalov, J. Sánchez-Barriga, N.Y. Shitsevalova, A.V. Dukhnenko, V.B. Filipov, S. Gabáni, K. Flachbart, O. Rader, E.D.L. Rienks: *Samarium hexaboride is a trivial surface conductor*, Nature Communications 9, 517 (2018)
8) N. Emi, N. Kawamura, M. Mizumaki, T. Koyama, N. Ishimatsu, G. Pristáš, T. Kagayama, K. Shimizu, Y. Osanai, F. Iga, T. Mito: *Kondo-like behavior near the magnetic instability in* SmB_6*: Temperature and pressure dependences of the Sm valence*, Physical Review B 97, 161116(R) (2018)
9) M. Človečko, E. Gažo, M. Kupka, P. Skyba: *Magnonic analog of black and white hole horizons in superfluid* ^{3}*He-B*, Physical Review Letters 123, 161302 (2019)
10) M. Človečko, P. Skyba: *Quartz tuning fork – A potential low temperature thermometer in high magnetic fields*, Applied Physics Letters 115, 193507 (2019)
11) D. Rak, M. Ovadová, M. Sedlák: *(Non)existence of bulk nanobubbles: The role of ultrasonic cavitation and organic solutes in water*, Journal of Physical Chemistry Letters 10, 4215-4221 (2019)
12) B. Michon, C. Girod, S. Badoux, J. Kačmarčík, Q. Ma, M. Dragomir, H.A. Dabkowska, B.D. Gaulin, J.-S. Zhou, S. Pyon, T. Takayama, H. Takagi, S. Verret, N. Doiron-Leyraud, C. Marcenat, L. Taillefer, T. Klein: *Thermodynamic signatures of quantum criticality in cuprate superconductors*, Nature 567, 218 (2019)
13) P. Neilinger, J. Greguš, D. Manca, B. Grančič, M. Kopčík, P. Szabó, P. Samuely, R. Hlubina, M. Grajcar: *Observation of quantum corrections to conductivity up to optical frequencies*, Physical Review B 100, 241106(R) (2019)

14) V.Yu. Verchenko, A.O. Zubtsovskii, Z. Wei, A.A. Tsirlin, M. Marcin, A.V. Sobolev, I.A. Presniakov, E.V. Dikarev, A.V. Shevelkov: *Endohedral cluster superconductors in the Mo–Ga–Sn system explored by the joint flux technique*, Inorganic Chemistry 58, 15552 (2019)
15) M. Bravo-Hernandez, ..., Z. Tomori, ... M. Marsala: *Spinal subpial delivery of AAV9 enables widespread gene silencing and blocks motoneuron degeneration in ALS*, Nature Medicine 26, 118-130 (2020)
16) J. Kubacková, G.T. Iványi, V. Kažiková, A. Strejčková, A. Hovan, G. Žoldák, G. Vizsnyiczai, L. Kelemen, Z. Tomori, and G. Bánó: *Bending dynamics of viscoelastic photopolymer nanowires,* Applied Physics Letters 117, 013701 (2020)
17) H. Herrmann, P. Hlawenka, K. Siemensmeyer, E. Weschke, J. Sánchez-Barriga, A. Varykhalov, N. Y. Shitsevalova, A. V. Dukhnenko, V. B. Filipov, S. Gabáni, K. Flachbart, O. Rader, M. Sterrer, E.D.L. Rienks: *Contrast reversal in scanning tunneling microscopy and its implications for the topological classification of SmB_6*, Advanced Materials, 1906725 (2020)
18) G. Zhang, T. Samuely, N. Iwahara, J. Kačmarčík, Ch. Wang, P.W. May, J.K. Jochum, O. Onufriienko, P. Szabó, Sh. Zhou, P. Samuely, V.V. Moshchalkov, L.F. Chibotaru, H.G. Rubahn: *Yu-Shiba-Rusinov bands in ferromagnetic superconducting diamond*, Science Advances 6, eaaz2536 (2020)
19) R. T. Leriche, A. Palacio-Morales, M. Campetella, C. Tresca, S. Sasaki, Ch. Brun, F. Debontridder, P. David, I. Arfaoui, O. Šofranko, T. Samuely, G. Kremer, C. Monney, T. Jaouen, L. Cario, M. Calandra, T. Cren: *Misfit Layer Compounds: A Platform for Heavily Doped 2D Transition Metal Dichalcogenides,* Advanced Functional Materials 2007706 (2020)
20) M. Žemlička, M. Kopčík, P. Szabó, T. Samuely, J. Kačmarčík, P. Neilinger, M. Grajcar, P. Samuely: *Zeeman-driven superconductor-insulator transition in strongly disordered MoC films: Scanning tunneling microscopy and transport studies in a transverse magnetic field,* Physical Review B 102, 180508(R) (2020)
21) Ch. Marcenat, T Klein, D. LeBoeuf, A. Jaoui, G. Seyfarth, J. Kačmarčík, Y. Kohama, H. Cercellier, H. Aubin, K. Behnia, B. Fauqué: *Wide Critical Fluctuations of the Field-Induced Phase Transition in Graphite*, Physical Review Letters 126, 106801 (2021)
22) A. Urbanová, I.H. Ezenwajiaku, A.N. Nikitin, M. Sedlák, H. Vale, R.A. Hutchinson, I. Lacík: *PLP-SEC Investigation of the Influence of Electrostatic Interactions on the Radical Propagation Rate Coefficients of Cationic Monomers TMAEMC and* MAPTAC, Macromolecules 54, 3204 (2021)

IV.) *Increase the ambitions in international large-scale projects by striving towards leading positions*. *Increase the ambitions regarding European collaboration programmes.*

Except bilateral and trilateral projects, leading scientists of IEP SAS tried to submit a number of international projects like H2020, ERANET, ESA, COST, JRP, etc., several of which were approved and produced excellent results. Researchers from large-scale collaborations (ALICE CERN, ATLAS CERN, JEM-EUSO) always play important role in common projects.

Within the years 2016-2021 new H2020 projects were submitted:

1) H2020-COMPET-2016: (SPIRIT), project No. 730064, PI in Slovakia: Kudela K.
2) H2020-MSCA-ITN-2016: *Magnetic Energy Conversion Academy* (MINERVA), project No. 721238, PI in Slovakia: Škorvánek I.
3) H2020-MSCA-ITN-2016: *Field sensitive soft composites for microwave and THz applications* (FISSCO), project No. 721891, PI in Slovakia: Tomašovičová N.
4) H2020-NMBP-2016-two-stage: *Multifunctional nanovehicles for monitoring and treatment of neurodegenerative diseases* (ANIMA), project No. 720479, PI in Slovakia: Gažová Z.

5) H2020-FETOPEN-1-2016-2017: *Towards Hybrid Efficient Refrigeration Materials: A new paradigm for advanced cryogenics* (THERM), project No. 737233, PI in Slovakia: Škorvánek I.
6) H2020-MSCA-ITN-2017: *Cooling and Electricity from Magnetocaloric Materials* (COOLECTRA), project No. 764883, PI in Slovakia: Škorvánek I.
7) H2020-WIDESPREAD-04-2017 (TeamingPhase1): (SAMSIT), project No. 763811, PI in Slovakia: Samuely P.
8) H2020-WIDESPREAD-05-2017-Twinning: *Advanced Scanning PRobe Microscopy: beyond Amyloid TOpographic imaging* (PRATO), project No. 810077, PI in Slovakia: Gažová Z.
9) H2020-INFRAIA-2018-1: *European Microkelvin Platform* (EMP), project No. 824109, PI in Slovakia: Skyba P. – **accepted**
10) H2020-WIDESPREAD-04-2018: *Strengthening of the research and innovation team for development of functionalized SuperParamagnetic Iron-Oxide NANOparticles for cancer treatment*, project No. 210562724, PI in Slovakia: Kopčanský P.
11) H2020-LC-CLA-2018-2: *Addressing knowledge gaps in climate science, in support of IPCC reports* (SEVAN), project No. 821199, PI in Slovakia: Langer R.
12) H2020-LC-GV-2018 (Building a low-carbon, climate resilient future: Green Vehicles): *Low Cost and Efficient Electrical Maschine for Electrified Vehicle* (CAMELEON), project No. 824344), PI in Slovakia: Škorvánek I.
13) H2020-MSCA-ITN-2018 (Marie Sklodowska-Curie Actions, Innovative Training Networks): *Cooling and Electricity from Magnetocaloric Materials* (COOLECTRA), project No. 813968, PI in Slovakia: Škorvánek I.
14) H2020-SC1-2018-Single-Stage-RTD: *Bioactive molecular machines for novel light-triggered treatment and diagnostics of Alzheimer's disease* (DISARMER), project No. 825960, PI in Slovakia: Gažová Z.
15) H2020-FETOPEN-2018-2019-2020-01: *Amyloid detection and inhibition by Azo compounds workbox* (ATTACK), project No. 863118, PI in Slovakia: Gažová Z.
16) H2020-MSCA-ITN-2019 (Marie Sklodowska-Curie Actions, Innovative Training Networks): *Novel Technologies for Efficient Thermal and Energy Management* (EsTEEM), project No. 860498, PI in Slovakia: Škorvánek I.
17) H2020-SPACE-2018-2020: *Study and Monitoring of Space Weather and Atmospheric Processes with a Network of Particle Detectors Located at Different Geographic Locations and Altitudes* (SEVAN), project No. 870441, PI in Slovakia: Langer R.
18) H2020-Excellent Science-101001646 (ERC Consolidator Grant): *Enhancement of superconducting Tc in 2D thin films under pressure* (CEMENT), PI in Slovakia: Pristáš G.
19) H2020-MSCA-RISE-2020 (Marie Sklodowska-Curie Actions, Research and Inovation Staff Exchange): *Development of smart magnetic materials for sensing applications* (SenSMAT), project No. 101008143, PI in Slovakia: Škorvánek I.
20) H2020-NMBP-ST-IND-2020-singlestage: *System for detection of the inhomogeneous distribution of magnetic field based on liquid crystals with magnetic nanoparticles* (MAGNETODETECTOR), project No.958166, PI in Slovakia: Tomašovičová N.
21) HORIZON-EIC-2021-PATHFINDEROPEN-01: *Inhibition of α-Synuclein Aggregation by Late Embryogenesis Abundant Proteins: A New Approach to Treat Parkinson's Disease* (LEAPSynPD), project No. 101046711, PI in Slovakia: Gažová Z.

IEP SAS is a key member of the European Microkelvin Platform (EMP) – a consortium of the European (and world) leading ultra-low temperatutre laboratories providing not only forefront fundamental physical reserach and innovations at low and ultralow temperatures but also provide the access to own experimental infrastructure. The EMP consortium has been granted by the EU Commission’s grant European Microkelvin Platform, grant number 824109 (http://emplatform.eu) applied within the call H2020-INFRAIA-2018-2020 European Advanced Experimental Infrastructures.

V.) *Investigate the reason for the apparently high drop-out of PhD students*.

Study control:
Since 2015, regular PhD seminars are organized, where every student presents recent results and other activity realized during last academic year.
Healthy competition:
PhD students with already published results often compete with young scientists in the Competition for Young Scientists of IEP SAS at the end of every year and subsequently they are awarded and financially supported. In addition, PhD students of IEP SAS with excellent results compete with young researchers at various national competitions.
New attractive accredited programmes of doctoral studies:
Since 2016, there were introduced three new accredited programmes: Advanced materials, Biophysics and Physical engineering of advanced materials, to increase interest in the PhD study and offer high quality supervisors.
New internal rules:
Since 2020, new Internal doctoral study assurance system has been approved by Scientific council of IEP SAS to increase quality of PhD study and reduce number of quitted students. Approved rules include e.g.: tightening the approval of new supervisors from researchers of IEP SAS and new PhD topics as well as tightening the selection of candidates for PhD study. The graduating doctoral student must prove at least one of his / her own quality publications, active participation in the conference and business stay abroad.
Project responsibility:
Since 2019, SAS Presidium approves Call for applications under the Grant Programme for SAS PhD students – Doktogrant – every year. The Grant programme for SAS PhD students is the SAS activity with intend to support scientific projects for students of a daily form PhD study carried out within SAS organizations. The aim is to financially support high-quality project proposals, which will be implemented during PhD studies as a coherent part of projects and which can be realized within one year. A number of PhD student from IEP SAS applied for this project and 4 of them received the funding.
The consequence of the improvements mentioned above is that:
Number of defended PhD students = 23
Number of quitted PhD students = 5

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

The Institute of Experimental Physics (IEP) of the Slovak Academy of Sciences (SAS) in Košice is one of the leading centers for physics-related research in Slovakia. This institute is a home-base for researchers who are nationally and internationally recognized for their contributions to scientific advancement. Research performed at the institute grows gradually in its quality and impact in the long term. In the next period, the institute will strive to keep up with fast changing world in order to respond to challenges the world is facing in technological, environmental and public health domains. Innovations using quantum technology, targeting diverse topics spanning from exploration of vaccines to climate change, have the power to outperform any existing technologies; biotechnology, as another example, enables new solutions in tackling diseases or cleaning up pollution.

The research at the Institute within the next five years will be closely connected to various contemporary challenges. As highlights we mention some of them: we will take part in the national framework for the new rapidly developing field of quantum communication infrastructure and quantum computation; biotechnology will be addressed via development of new textile composite (nano)materials, new therapies for amyloid-related diseases or lab-on-chip applications; environmental issues will be dealt with in research leading to enhancement of energy savings and improvement of energy harvesting, including the development of new hydrogen storage methods for various applications including zero-emissions vehicles. Research groups of the institute will also continue being the important integrant in large

international space missions and experiments (ESA JUICE, JEM-EUSO), as well as in ALICE and ATLAS experiments at CERN.

We are also aware that the rising fear of new technologies and lack of public trust in science in general, despite of the tremendous advances they have already provided, may prevent innovations from having the impact they promise. We are committed to increasing the efforts to educate and engage the public to ensure that science and technology truly live up to their potential.

In order to meet our goals and make the most of the effort, the institute will support following activities: i) basic research in order to expand human knowledge, ii) international collaborations, especially (but not exclusively) under the European flagship projects; iii) research activities that have a potential of rapid transfer of knowledge from basic research into innovative products and technologies; iv) expanding the expertise of the research personnel; v) the teaching and training of students at different education stage; vi) the scientific popularization on the regional and national level.

IEP SAS also plans to be active on national/regional level by providing its expertise in the Cassovia New Industry Cluster (CNIC), a very recent endeavour of three Košice universities, three research institutes of SAS (including IEP SAS) established in Košice, University hospital of Košice, Regional government, City of Košice and private companies (https://cnic.sk). The goals of the CNIC project are based on a synergy of excellent knowledge presented in the region, and the creation of instrumentation and infrastructure for top research and technology transfer to industry in the fields of biomedicine, materials research, quantum & information technologies, green energy & digital technologies.

Research strategy of the scientific departments

Centre of Low Temperature Physics (CLTP)

CLTP as a member of the most prestigious club of the world low temperature laboratories – the European Microkelvin Platform (EMP) will remain an open access point for academic researchers willing to experiment at ultralow temperatures using unique in house developed infrastructure capable for investigating quantum materials and technologies. Our participation in EMP project shifts the development of unique experimental methods to their cutting edge and opens new collaborations in the field of low temperature physics and quantum technologies. CLTP is a key partner of the Slovak National Research Platform on Quantum Technologies - QUTE (http://qute.sk) that is creating a national framework for the new rapidly developing field of quantum communication infrastructure and quantum computation. Just recently, our consortium has applied for a new project – skQCI within EU call: DIGITAL-2021-QCI-01 related to EU Secure Quantum Communication Infrastructure, part of the EuroQCI mission. Realisation of this project will enable to build up the quantum communication infrastructure across the whole country. In the near future we would like to continue and focus our work on forefront research at low and ultra low temperatures and transfer of knowledge from fundamental research to application. In particular, we shall carry on research and application of quantum systems as model structures for study and simulation of physical processes that currently are beyond mankind technological capabilities. We plan to investigate also nontrivial physical processes of various quantum systems that are emerging as a consequence of their topological behaviours, and are represented e.g. by Majorana particles – fundamental elements of Q-bits, by interplay with magnetism, topology and superconductivity, quantum criticality, etc. Our new Impulz project “Topological superconductivity in quantum 2D devices - TopoQ2D” and the new Quantum Materials research laboratory, built in the framework of this project will play a key role in this research. Focus on quantum nanotechnology, quantum materials / systems and quantum communication infrastructure, including quantum computing is going to be a key pillar of research at CLTP IEP SAS in the near future. The research will continue also in investigations of the metallic geometrically frustrated magnetic systems as well as superconducting properties of 3D/2D rare earth borides or high-entropy alloys, respectively.

Department of Materials Physics

The main activity will be focused on REBCO bulk single-grain superconductors. Research will be implemented within national projects (APVV, VEGA) and in cooperation with CAN Superconductors a.s. manufacturer of bulk superconductors and will focus on improving macroscopic superconducting properties in combination with mechanical properties. Special attention will be paid to the study of the possibilities of simultaneous optimization of the efficiency of pinning centres and prevention of crack propagation in these brittle ceramic materials. We will focus on optimizing the particle size distribution of pinning centres in the form of non-conductive particles RE211. Our results to date suggest that an optimized bimodal RE211 particle size distribution may lead to the expected effects. The quality of the boundary between two REBCO bulk crystals grown from two seeds will also be studied to optimize the properties of large multy-seeded REBCO bulks. This activity will be coordinated with cooperating foreign laboratories (mainly University of Cambridge, SIT Tokyo, University of Caen, JTU Shanghai) and we plan to apply for a European project as a partner of CAN Superconductors a.s. In cooperation with a small company RV Magnetics a.s. and Pavol Jozef Safarik University in Košice we will study the structure and microstructure of magnetic Heusler alloys in the form of glass coated micro-wires suitable for application in sensors (joint project).

Department of Magnetism

Magnetic fluids as one of the pioneers of modern nanotechnology are still attractive for basic as well as applied research. Magnetic fluids and their composite systems have stimulated further research, especially in the field where nanoparticles, especially magnetic ones, give them the ability to manipulate them in an external magnetic field, thus changing the properties required in various applications:

- The hybrid materials based on liquid crystals (LCs) doped with magnetic nanoparticles (MNPs) reveal a great potential to improve current liquid crystal-based technologies. In this context, further enhancement of the sensitivity to the magnetic field may be achieved by long-term colloidal stabilization of larger MNPs with improved magnetic properties. Moreover, LC-mediated assembly of nanoparticles may not only lead to LCs with ferromagnetic properties but also to novel and complex, nanoparticle-based superstructures. The parameter space is large which opens up many possibilities for future studies on active matter and programmable liquid constructs.

- Novel alternative cooling and insulating liquid media such as oils based on liquefied natural gas, natural esters and new types of transformer oils. We will prepare novel nanofluids based on these oils by dispersing magnetic nanoparticles (fullerenes, graphene nanoplatelets or carbon nanotubes) for enhancing the cooling effectiveness. The nanofluids will be investigated from dielectric, insulating, magnetic and heat transfer properties point of view. Finally, their cooling effectiveness will be tested in loaded power transformers. Therefore, the future research is believed to contribute to the development of advanced liquid media for cooling and insulation in electrical engineering, the application of which will have a potential impact on electric power saving, electrical equipment service life and protection of the environment.

- The research on ferrofluids for electrical engineering applications will be focused on energy saving and energy harvesting. Novel hybrid ferrofluids based on insulating liquids will be developed with the aim to obtain highly efficient cooling and insulating liquid medium for electrical devices. The research will be also oriented on thermal-to-electric energy conversion by developing ferrofluids based on ionic-liquids; i.e., colloidal dispersions of magnetic nanoparticles in ionic liquids. The third research activity will be devoted to investigation of ferrofluids for mechanic-to-electric energy conversion in wearable devices.

- One of the aims in future research is the development and preparation of new textile composite (nano)materials (usually exhibiting magnetic response), their detailed characterization, and subsequent use in various fields of biosciences, biotechnology, (bio)analytical chemistry, medicine and environmental technologies. (Nano)textile materials can be functionally modified by modifying the polymer, fiber, and textile structures by application of chemical, physical, and biological treatments, in order to develop textile

materials applicable in wide range of applications. In addition, the incorporation of ferro- or ferrimagnetic (nano)particles (e.g. magnetite or maghemite (nano)particles by magnetic fluid treatment or using microwave assisted synthesis) or a piece of magnetic iron wire into parts of modified (nano)textiles allows them to be separated very quickly and with 100% recovery even from large volumes of solutions and suspensions, using appropriate magnetic separator. Modified textile materials (both in magnetic and nonmagnetic form) can find very important applications in many areas of biosciences, biotechnology, (bio)analytical chemistry, catalysis, medicine and environmental technology.

We are going to continue in study of multiferroic and another functional materials with perovskite structure in respect to hydrogen storage or application of colloid with nanoparticles for hyperthermia. The future projects will be targeted to substitutional solid solutions and construction of magnetic phase diagrams in RTO_3 system (R = Nd, Pr, Sm, Tb, Dy and T = Ti, Cr, Mn, Fe). Oxygen content affects physical properties of this system. The defect structure can be used for hydrogen storage. Experimental techniques like crystal growth of single crystals, synthesis of magnetic nanoparticles and study of various physical properties are complemented by theoretical approach using Density functional theory. Our project will serve as starting point for re-examining the effect of oxygen content on physical properties of $RMnO_3$ multiferroic compounds. The concept of storing hydrogen in the vacancies of these compounds is novel as well smart hyperthermia based on colloid containing magnetic nanoparticles of manganites.

Department of Applied Magnetism and Nanomaterials (DAMN)

The research activities of the DAMN will focus on development of novel soft and hard magnetic nanocrystalline alloys and composites with potentially improved application-oriented properties. Their desired properties will be achieved by targeted compositional, structural and shape modification and by the choice of optimal thermomagnetic treatment. Here of particular interest will be the employment of two unconventional techniques of thermal processing constructed recently by our group at IEP SAS. We plan to use new facility for ultra-rapid annealing of thin metallic ribbons where typical annealing times take few seconds. High heating rates and much shorter processing times as compared to conventional annealing allow to extend the composition interval where the annealed melt-spun ribbons are still capable to form nanocrystalline structure. The second technique for unconventional thermal processing of materials available at our department is the annealing of materials in presence of high magnetic fields (up to 14 T). We hope that the utilization of the above-mentioned unconventional processing techniques will help us to develop new materials with interesting combination of structural and magnetic properties. Our attention will be also devoted to nanocrystalline alloys in the form of bilayer ribbons prepared by a double-nozzle planar flow casting technique, which offers the possibility of simultaneous formation of two homogeneous layers connected through solid interface, with different composition and uniform thickness along the ribbon length. The resulting bilayer ribbons are interesting for their intrinsically graded functional properties, which can be used in design of specific sensors or actuators.

Department of Biophysics

The long-held structure-function paradigm where well-defined native protein structures are needed for their function has been considered the “Holy Grail” of structural biology for a long time. This approach is valid for structurally well-defined proteins called globular proteins. However, recent data demonstrate a large proportion of the proteins from all domains of life, which are rich in sequences that do not fold into regular structures, commonly known as nonglobular proteins (NGPs). NGPs comprise intrinsically disordered regions, repeats, low-complexity sequences, aggregation-prone and phase-separating sequences. NGPs participate in many biological processes of DNA and RNA binding, transcription, translation, cell-cycle regulation and signaling. NGPs also play a central role in age-related amyloid-related diseases and systemic disorders such as Parkinson’s and Alzheimer’s and type II diabetes. We plan to understand the protein sequence-structure-dynamics-function relationship at the molecular/atomistic level using biophysical experimental and computational techniques. We will focus on the role of hydrophobic interactions in formation and stability of protein amyloid structures and clarify a link between oxidative stress and

amyloid fibril formation. Moreover, we will search for the effective inhibits of the amyloid aggregation. This integrative approach will provide new therapies for amyloid-related diseases.

Amyloid aggregates formed by proteins also constitute a robust platform with a large potential for engineering applications and novel biomaterials such as amyloid fibril networks, amyloid-based layers or gels for applications such as drug delivery, controlled release of active drugs from amyloid conjugate, tissue repair/engineering, metal nanowires, and biosensors. We will also utilize the full-length native globular proteins such as insulin, lysozyme, and α-lactalbumin to create fibrillar templates and networks with controlled properties. Amyloid structures have a high affinity for a wide range of nanoparticles. We plan to study the potential of amyloid-NPs ((Au, Ag, Pd as core) based hybrid for catalytic properties for reduction, oxidation, or C-C coupling of important industrial reactions.

In parallel, the formation of functional amyloid structures based on spider silk protein will be studied. We plan to engineer spider-amyloid based nanocomposites for biomedical and biotechnological applications (fabricate the spider silk-based nanocomposites able to: a) immobilize proteins; b) act as nanoparticles or drug carriers).

In the near future, we plan to develop biomedical lab-on-chip (LOC) applications based on light-driven mechanical microstructures fabricated by two-photon polymerization and integrated into the microfluidic LOC environment. We are especially focused on flexible (deformable) micro-structures that have not been used in biomedical applications yet. Two well-defined LOC application areas are targeted: micro-rheology and single-cell manipulation. Our main goal is the development of micro-viscometers utilizing the effect of the surrounding fluid medium on the deformation (deflection) of flexible micro-cantilevers. Two types of structures will be prepared: a) anchored to the bottom glass surface and b) optically movable ones placed inside the micro-fluidic system. Such light-driven elastic micro-robots should be able to capture, transport, and release single live cells. Their function will be automated to build multicellular systems, mimicking the tissue conditions autonomously. To facilitate the flexible microstructure development and optimization, the material properties of the photo-polymers will be determined by comparing experimental deformation data with the results of numerical simulations.

Cancer is the second leading cause of death after cardiovascular disease in almost all European countries. Over the past several decades, the principle types of cancer therapies have been chemotherapy, radiation therapy, and surgery. The magnetic nanoparticles represent great potential in the diagnosis and treatment of cancer due to their unique properties, such as their biocompatibility, simple fabrication technology, and the ability to be manipulated with an external magnetic field. In this context, we plan to continue developing biocompatible multifunctional magnetic nanoparticles and evaluate their diagnostic and therapeutic potential for application in oncology. The first key step to achieving the desired goal will be the synthesis of magnetic nanoparticles and the functionalization of their surface with biocompatible materials suitable for radioactive indicator binding to monitor their biodistribution using radioactive indicator methods in healthy rats. Moreover, the stability of radiolabeled MNPs in vitro will be investigated. The second important goal will be to conjugate chemotherapeutic drugs of natural origin such as betulinic acid and / or hypericin to magnetic nanoparticles as a new approach to cancer treatment. The suitably selected nanoparticles with the immobilized drug could enhance chemotherapy efficacy by increasing drug concentration at the target site, so they could reduce its adverse effects or enhance the detection sensitivity. Moreover, a combination of MRI, hyperthermia, and radiotherapy with magnetic drug targeting could represent a significant advance in cancer disease treatment and a substantial improvement in the survival of oncological patients.

Department of Experimental Chemical Physics

The strategy in this department will be to follow up on the successful patent activity from recent years. Three patents were awarded and three patents are currently pending. Since these patents relate to food safety and drug safety, we plan to work closely with state authorities in the area of contaminants screening and with the private sector in the area of contaminants removal (product purification). Paradoxically, all patent outcomes came from our long-term purely basic research focused on interesting, yet poorly understood and

puzzling physical phenomena in chemical systems. Methodologically, our department is focusing on the characterization of macromolecular and nanoparticle systems, especially in situations where the nature/origin of nanoobjects is unknown. Given the commercial infrastructure, original in-house developed methods, and methodological expertise, our department represents a unique workplace in this area at national level. Within the Cassovia New Industry Cluster (CNIC), we plan to broaden our methodology portfolio by acquiring small-angle x-ray scattering (SAXS) equipment. Our research focus will be on potential existence of stable bulk nanobubbles. While it is currently not exactly known if such nanoobjects can really exist and at which conditions, their application potential is tremendous. While microbubbles are currently used as USG contrast agents for blood circulation visualization, nanobubbles would help to visualize tissues, including tumor issues and other pathological tissues since nanobubbles can penetrate the smallest blood vessels.

Department of Space Physics

The research strategy of DSP will in the next years focus on cosmic rays, space weather, and ionospheric research. The objectives are to apply machine learning methods, mainly in the space weather field, and build open-source models with web service for all cosmic rays models developed at DPS in the last decades. We will give high importance to continuation of the experiments and measurements realized by DSP, such as experiments at the detached observatory of the institute at Lomnicky stit (neutron monitor, SEVAN), and participation in space experiments as ESA JUICE mission and JEM-EUSO experiment.

Department of Subnuclear Physics

The future research activities of the Department of Subnuclear Physics will continue to be focused on the experimental programme at CERN with the emphasis given to the ALICE and ATLAS experiments. The ALICE experiment underwent a major upgrade of many subdetectors and systems and is now ready for the forthcoming long data taking period. The ATLAS experiment expects its major upgrade later. In order to reach rarer physical processes, the Large Hadron Collider is lead towards a High Luminosity LHC which will reach its operational stage in around 2029. In the next 5 years physicists from IEP SAS will participate in data taking, hardware and software development and physics analysis, and also in adaptation of all computing facilities - including GRID farm at IEP SAS - to fulfil growing demands. In the more distant future, there are plans to build a successor of the ALICE detector and keep the ATLAS in shape for HL-LHC.

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