Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Physics of the CAS, v. v. i.

Fields, in which the Institute registered its teams:

Physical sciences

Observer representing the Academy Council of the CAS: Tomáš Kruml
Observer representing the Institute: Jan Kočka, substitute observer Milada Glogarová

Commission No. 3: Physical sciences
Chair: Prof. John Dainton

Date(s) of the visit of the Institute: October 15 - October 23, 2015
Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:
No. 1 - Astroparticle Physics; No. 2 - Semiconductors; No. 3 - Spintronics and Nanoelectronics; No. 4 - Structural Analysis; No. 5 - Magnetics and Superconductors; No. 6 - Thin Films and Nanostructures; No. 7 - Optical Materials; No. 8 - Magnetic Nanosystems; No. 9 - Dielectrics; No. 13 - Microscopic theory of many-particle systems; No. 14 - Laser-matter Interaction and Chemical Physics; No. 15 - Laser Development and Applications; No. 16 - ELI Beamlines; No. 17 - Experimental particle physics; No. 18 - Particle physics theory and phenomenology; No. 19 - Optical and biophysical systems; No. 20 - Physical processes in low temperature plasma; No. 21 - Plasma-based technologies and analysis of functional nanomaterials; No. 22 - Classical and quantum optics

A. Evaluation of the Institute as a whole

1. Introduction

The Institute of Physics comprises research teams across a wide range of research activities. This is both expected is essential if nationally the Czech Republic is to continue to be identified globally as an important centre for physics research with all that this brings for national well-being. These expectations are fully appreciated as an important prerequisite by the leadership of almost all research activities in the Institute. This should be born in mind in that follows in this evaluation, both of the Institute as a whole and of its individual teams.

The report of this evaluation is based not only on external assessment of publications and related output, such as conference presentations, outreach, and international visibility, but also on a visit to the Institute by the panel of evaluators for a period of three days in October 2015 (after visits to other Institutes engaged in part in physics research). During this visit to the Institute of Physics, the leaders of each research team presented to the panel the achievements of, and plans for, their teams, took the opportunity if they wished to raise issues with the panel, answered questions from members of the panel, and engaged sometimes in lively and worthwhile discussion with them. These sessions were open to, and were attended by, staff of the Institute.

The panel also met and discussed with the Director and the Council of the Institute, after having been made aware of the overall legal framework in which research institutions function in the Czech Republic.

A special visit was also organised for the panel to visit the new ELI laboratory.

2. Strengths and Opportunities

The Institute is well known internationally in many areas for the importance of its scientific work.

As the individual evaluations of teams demonstrate, and as is always the case in scientific research, research teams are at different stages of maturity. There is some noticeable evidence that a few mature subjects have been pursued for too long in some activities. In general, however, the Institute has a sensible and prudent approach to matching the interests and expertise of its staff to enable important work. This attitude secures the collective well-being of the Institute of Physics as a recognised international centre of scientific excellence. The panel concludes therefore that the effectiveness and functionality of the Institute with respect to managing and to monitoring its activities, to deciding on its future research, and to co-ordinating the use of its resources, are adequate. Moreover, the panel finds that in general staff identify themselves with the Institute and its purpose as a scientific centre of importance and significance which more than the mere sum of its parts to its national and international visibility.

As long as this collective ethos remains, the Institute is clearly well placed to react flexibly and efficiently so as to grasp new scientific opportunities and to meet challenges which arise. This is exemplified in the reporting period by the impressive and rapid establishment and progress of the ELI project, which (on the basis of the application of physics to enable new pure and applied science) is in the process of enabling a step-change in the international perception both of the growing excellence of Czech science, and of its importance for, and influence on, the future of world science. Such a state of affairs is of course highly desirable and welcome. It also brings new challenges in the form of misplaced, even excessive, bureaucracy which can stifle innovative, individual, originality, and which can bring unhelpful pressure to bear on the distribution of limited national

resources within an Institute such as this. Therefore, ensuring a wholly positive outcome for the continuing excellence of the Institute's science in the new era of ELI operation with the huge scientific opportunities which it brings, will therefore require even more careful, prudent and wise management and direction of the Institute than hitherto.

3. Weaknesses and Threats

The huge opportunity that ELI brings should not be regarded in any way as a weakness and a threat to the Institute of Physics could pose a threat if the challenges which it could bring regarding resource allocation and research emphasis are not well managed. The panel is confident that the Institute's effective management and direction will ensure that any such concerns will be dealt with adequately.

Concerning the present state of research in the Institute, the panel gained an impression that communication between some teams, and even within teams, in particular in Condensed Matter Physics is not always optimal. Where possible, team reports do not make any reference to related research work by other teams. Collaboration between different teams, either in research work itself or in stating plans for the future, is not reported. Nor was the possibility that this impression of the panel may be incorrect disputed in the discussions during the visit to the Institute. Furthermore, within some Condensed Matter teams, and even sometimes within groups in such teams, results from a multitude of rather disjointed research topics are reported. The panel points out that these issues, if indeed they are the case in the Institute, could be a continuing obstacle to greater international visibility. "Managing" such an issue of course has also to be tensioned against the importance of encouraging and sustaining the individual originality which is also essential for top class research. The panel also recognises that these issues may arise because of lack of geographical co-location, in which case a solution may not be straightforward.

A second matter that merits some thought, which ,ay possibly lead to reconsideration of organisation in the Institute, is that of theoretical physics. The Institute has two groups, one each in condensed matter and in particle physics. Two models, one with theorists and experimentalists together in specifically identified research teams, and the other with a theoretical physics research team per se, can bring, and have brought, success in the Institute. The appropriateness or otherwise of both models always depends on the nature of the theoretical work of research teams, their topics, and on the degree to which those staff directly involved, together with the leadership of the Institute, want a unified team focused on developing new theoretical concepts and methods ("theory for theory's sake") as well as application of concepts and methods to experimental results. In particle physics, these both such aspects are usually accommodated in a single theoretical team. In other areas of physics and physical science both models above can apply equally well. It could be that the best interests of the Institute are the establishment of a single theoretical physics team covering all theoretical aspects of relevance to experimental teams, or of a Theoretical Condensed-Matter Physics team alongside the Theoretical Particle Physics team, with other areas having their own theorists if such organisation is deemed inappropriate for them. The consensus of the panel is that some sort of rationalisation with the intention of further enhancing international recognition of the institute's overall theoretical research, while at the same time providing better scientific ties internationally, is well worth considering.

4. Recommendations

The two issues discussed in item 3 above lead to the following suggestions:

1. review of disparate work across teams with the aim of providing beneficial cohesion and collaboration where appropriate and advantageous without hindering individual originality and innovation, and
2. consideration of the structure(s) and organisation of theoretical work in the Institute with a view to ensuring further enhancement of the Institute's international reputation in theoretical physics.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The evidence for the quality of the results can be found in the outcome of Phase I evaluations and in the comments of the Panel on the work reported by the individual research teams and the discussions of the panel with the leadership of all research teams.

Where there continues to be any lack of clear conclusion by the Panel concerning a particular research team, and in only a few places does such a lack of clarity remain, it is documented as part of that teams "Detailed Evaluations".

Declaration on the involvement of students in research

If there was any lack of clarity following the material submitted to the panel concerning the involvement of research students in the work of a team, satisfactory answers were obtained at the time of the discussions with the teams.

Declaration on societal relevance

All research teams are well aware of the importance of outreach. They clearly reported such activities in their reports to the panel, and were ready and willing to discuss the context and the nature of them. Without exception all were judged by the panel to have had some important impact as an outcome.

Declaration on the position in the international and national context

By virtue of the assessments of the individual research teams, for which individual statements of their international and national visibility and collaboration can found in the reports below, the Institute as a whole is also well placed and well respected both intemationally and nationally.

The most significant evidence for the international reputation of the Institute which is achieved during this reporting period is found in its important role in underpinning the international scientific reputation which secured the ELI project for the Czech Republic and which now brings local expertise to the project.

Declaration on the vitality and sustainability

Each research team has been considered in relation to vitality and sustainability. The outcomes can be found in each report below. The collective vitality of the Institute is hard to gauge given its size. Some comments are made above concerning intra and inter-team collaboration and cohesion which may not be completely optimal for the vitality, and therefore the collective sustainability, of the Institute.

Declaration on the strategy and plans for the future

The Director and the Council outlined a vision for the future in discussions with the Panel which raised no major concerns for the future of the Institute beyond issues which arise and are documented in respect of individual research teams below.

The two issues discussed in item 3 above for which recommendations are given in item 4 above should be taken into consideration when planning for the future.

B. Evaluation of the individual teams

Evaluation of the Team No. 1: Astroparticle Physics

1. Introduction

The primary activity of the astroparticle physics group consists of operations within large international projects: currently the Pierre Auger Observatory (PAO), while two more projects – the Cherenkov Telescope Array (CTA) and the Large Synoptic Survey Telescope (LSST) – are under preparations. The team involvement within PAO is manyfold and has grown over the years into a significant contribution to the whole programme. The main tasks are (i) construction and operation of fluorescence telescopes, able to directly observe air showers triggered by an impact of energetic cosmic-ray particle, (ii) atmospheric monitoring above PAO, using a robotic telescope FRAM (designed and constructed by the team), and (iii) measurement interpretations, such as calibration of the cross-section of the impinging high-energy particles or composition studies. The team is very active as evidenced by numerous PAO publications co-authored by the team members in the evaluated period.

2. Strengths and Opportunities

The group position within the PAO operations is bold. If the PAO upgrade is fully financed, it would mean a prospect of another ~ 7-10 years of operations and would keep the team busy. Additionally, the proposed contribution to CTA, and to a lesser extent also LSST, develops from the proven expertise and results which the group gained in the PAO project. This should help establishing a solid position of the team within these future projects.

3. Weaknesses and Threats

There are no manifest weaknesses in the team during the evaluation period. If anything is to be mentioned, a possible threat on a long-term is hidden in the way how the team operates. So far it only relies on huge international projects, which financing is not within capabilities of any individual partner.

4. Recommendations

The team has a clear and reasonable vision of their activity for the immediate period in the future. Therefore no specific recommendations are needed. We only add a thought about the team location. While it might seem at the first sight natural to incorporate it in the Astronomical Institute, its natural home is truly the Institute of Physics. This is because the astroparticle physics team uses tools and methods that are very similar to particle physics (also harboured at the Institute of Physics). The way how this team works, i.e. within a huge international consortia, is closer to operation of other teams in the Institute of Physics rather than those at the Astronomical Institute.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

Majority of science results were co-signed with other teams of the PAO consortium; in several cases the astroparticle physics team took the leading position. Overall, these results are highly visible and widely cited by the community. The team members also

participated on documents related to CTA and LSST. These are very useful and necessary steps toward the future projects, and they help to set the team's status within CTA and LSST projects. Several useful results were also obtained as a by-product of FRAM operations (in its spare time).

Declaration on the involvement of students in research

Members of the team conduct regular courses at Palacký University in Olomouc (Applied Physics and Instrumental Physics programmes). Apart from that, they supervised several bachelor, master and two doctoral theses during the evaluation period of 2010-2014. Given the limited number of staff members, the student involvement is rather significant.

Declaration on societal relevance

The outreach programme of this team is outstanding and hardly has a comparison among other institutions. This is mainly due to the long-term popularization work of dr. Jiří Grygar, but younger generation of researchers has also become involved in the past decade or so (Petr Trávníček and Michael Prouza). Palette of outreach activities ranges from regular TV and radio programs, public lectures, school and public observatories visits (J. Ebr being regular guide at the Štefánik observatory in Prague), to popularization journal articles and books. Members of the team are also editors of a major journal for amateur astronomers in the Czech Republic (Astropis).

Declaration on the position in the international and national context

The team earned a significant position in the international projects where it decided to participate. This concerns mainly the PAO, where the Czech contribution is highly visible, but a similar status is being gained in the CTA and LSST projects.

Declaration on the vitality and sustainability

The team, consisting of mainly young researchers, is very active. Over the evaluated period the team obtained a significant amount of grant support (mainly from the Ministry of Education on the Czech side and, importantly, also participated at 2 EU projects under FP7).

Declaration on the strategy and plans for the future

The plans for the upcoming years logically arise from the team’s heavy involvement in operations of PAO, and preparative works for CTA and LSST projects. As to the first, the undergoing upgrade of the system should imply operations till 2023 (according to available documents, provided they are fully funded) and thus keep the team busy.

Evaluation of the Team No. 2: Semiconductors

1. Introduction

The team focuses its research activity on semiconducting quantum dots (QDs) of nanometer size where the electronic states are confined in all three dimensions, resulting in a discrete energy-level structure which depends mainly on the size of QDs. The III-V semiconductors are direct semiconductors allowing a multitude of optoelectronic applications that have been realized, such as tunable LEDs, lasers, detectors and many others. Reflecting thus practical demands, the research of the team is primarily oriented towards reproducible preparation of MOVPE-grown heterostructures with InAs-based QDs emitting at telecommunication wave lengths of 1.3 μm and 1.55 μm. The team comprises four groups dedicated to preparation technologies, photoluminescence, transport properties, and theoretical modeling, respectively, with focus on III-V QDs imbedded in semiconductor heterostructures. The research in this direction is of primary importance for applications in tunable lasers, detectors, and solar cells. More recently, the team has been engaged in the fabrication of GaN-based structures pioneered by Japanese scientists some 20 years ago (Nobel Prize 2014).

2. Strengths and Opportunities

The newly acquired nitride laboratory LABONIT and the planned research into the nitride-based semiconductor structures of gallium nitride (GaN), aluminum nitride (AlN), indium nitride (InN), and their ternary and quaternary combinations which are at present important compound semiconductors, offer new opportunities. The consecutive research chain of preparation, and characterization with photoluminescence and transport measurements, together with theoretical modelling, is certainly an asset of the team.

3. Weaknesses and Threats

The field of material development and characterization of III-V devices for optoelectronic functionalities is internationally highly competitive, with worldwide academic and commercial R&D activities. It has reached a mature status where progress in applications can often be achieved only with huge R&D efforts. For a rather small group such as the team on working on semiconductors in the Institute of Physics, it is therefore advantageous to be in the possession of a unique selling point which needs to be expressed more clearly. Even rather specific issues such as the incorporation of a strain-reducing layer (SRL) to increase the wave length to the technologically important value of 1.3 μm, has been employed for 15 years with the first report on a GaAsSb SRL, the concept pursued by the CAS team, having been published 10 years ago.

The theory group works on rather diverse subjects such as the anomalous Hall effect in magnetic semiconductors, non-equilibrium dynamics of nanostructures, self-consistent T-matrix approach to superconductivity, and metrology (speed of light). While this is certainly legitimate research of generally high quality, it is highly partitioned. The impact and coherence of this work with regard to the main research thrust of the experimental groups of the team is not clear.

4. Recommendations

In view of the worldwide research activities in the field of III-V optoelectronic devices, the unique selling point of the team should be more clearly presented. In this respect, here the future focus on nitride-based QDs might be a promising possibility. The collaboration with other groups in academia and industry, as already started by the preparation group,

should be intensified. Theory devoted to modelling various aspects of semiconducting, such as microscopic understanding of the SRL-induced wave-length shift could be an asset of the team and potentially could be a guide towards optimizing device performance. A modelling feedback would strengthen the knowledge chain and give.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The research of the team is generally of high quality. Concerning the publications, the team always documented a fair share of the results obtained.

Declaration on the involvement of students in research

Here the team has a good record for the period 2000-2014, with two bachelor and master defences each, and four PhD defenses. Members of the team have occasionally taught courses at Czech universities (not Charles University).

Declaration on societal relevance

The activity of the team in this field is rather limited. There is mention of only one public appearance (on blue lasers, Czech Broadcasting Company).

Declaration on the position in the international and national context

As mentioned above, it is challenging for the team to acquire a positon that is internationally competitive. Although the team is internationally recognized, breakthrough results have in the past not been achieved frequently. In general, the research results are not published in top-notch international journals.

Declaration on the vitality and sustainability

The age structure of the team appears to be not very well balanced with three researchers below 30 years and eleven researchers above 55 years, but only five between 30 and 55 years of age. On the other hand, this age structure of the team offers the opportunity in the next few years to restructure the research focus.

Declaration on the strategy and plans for the future

With the development of nitride-based III-V semiconductor heterostructures, the team opened an interesting new path. Of course, again it will be difficult to compete internationally. As the main subject, the team “plan(s) to study quantum low temperature transport in diamond, GaN and ZnO based structures with special emphasis on ballistic transport, superconductivity and manifestations of the weak localization” as stated in the written report. These are rather mature subjects. There is unfortunately no inclination visible to enhance the impact of the team in the III-V semiconductor community. Although in the general introduction to their report the team mentions the possibility of next-generation optoelectronic devices with quantum information processors (a research field presently pursued in a number of leading laboratories worldwide) no activity is planned in tis respect.

Evaluation of the Team No. 3: Spintronics and Nanoelectronics

1. Introduction

The main directions of the research conducted by this group are focused on spin Hall and galvanic effects, on materials and nanodevices research and on spintronics in antiferromagnets. This unique combination of materials and device research, conducted at both experimental and theoretical levels, highly original and innovative, very well managed and organized, is extremely successful and highly recognized at the global scale. The quality of the personnel and that of the available infrastructure is outstanding. The group pays attention to protect their intellectual property, which apparently is of high value and can lead to significant commercial breakthroughs, by patents and specific industrial agreements, the fact that should be highly appreciated.

2. Strengths and Opportunities

The quality of their publications is outstanding, they are indeed world leading and include 16 various Nature publications. Equally important is a high ratio between their numbers of journal and conference publications (about 5), confirming their dedication to high quality research, which is much higher and better than for a typical research group of their size. A further strength is their apparent ability to direct their fundamental and applied research towards potential scientific breakthroughs resulting in novel practical implementations while taking care of properly protecting their intellectual property.

Such a very high quality group and with such a healthy approach to research has an excellent opportunity to successfully compete on the global market, where the interest and need for the novel materials and device technologies is growing fast.

The age structure of this team is excellent in terms of assuring the proper knowledge transfer and professional growth of the future high quality research personnel, and allows to look with a lot of confidence to their future.

3. Weaknesses and Threats

No particular weaknesses have been observed in this team, and the Panel sees no threats to its present direction of research.

4. Recommendations

Continue this outstanding quality, interesting and competitive research – congratulations!

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The quality of evaluated research is outstanding. The large majority of evaluated outputs of this team is world leading.

Declaration on the involvement of students in research

The team is very active in supervising students (currently 6 PhD and 5 MSc) with 1 PhD graduated during the evaluation period. The team gives regular lectures at local universities, and their supervised students travel frequently around the world to get additional training at the collaborating institutions abroad. The environment to conduct their research and the quality of supervision they are receiving are outstanding.

Declaration on societal relevance

The team is exceptionally active in the scientific activities at the international scene, and also in science and research popularization, including very frequent media interviews to present their research.

Declaration on the position in the international and national context

The team has established exceptional and successful collaboration at the international and national level, with both high quality academia and industrial partners

Declaration on the vitality and sustainability

The age profile of the team is very good and guarantees knowledge transfer and development of high quality research personnel within the team, and continuation and further development of its current research activities.

Declaration on the strategy and plans for the future

The plans for the future and strategy are well thought out and inspired by outstanding current research achievements.

Evaluation of the Team No. 4: Structural Analysis

1. Introduction

This department has a high reputation in methodical development of crystal-structure analysis, such as the crystallographic computing system JANA and the charge flipping program Superflip for resolving structures in different dimensions. This success has in the past enabled acquiring state-of-the-art instruments for single-crystalline and powder x-ray diffraction as well as electron diffraction.

Presently, the team is concerned with developing methods based on electron-diffraction tomography taking dynamical scattering effects into account. The development of structure analysis of magnetic compounds, based on low-temperature neutron-diffraction experiments, represents a direct link between crystallography and physical properties. A key physical mechanism affecting magnetic structures is the spin-orbit coupling (SOC) leading to crystal anisotropy. The effect of SOC on the electronic structure is important to understand the relation between structure and properties of magnetic materials. Resolving complex modulated structures requires continuous method development which is pursued by the team. The group working on mineralogical crystallography gives special attention to uranium minerals, which is a challenging task due to the complexity of their modular crystal structures and, in addition, is relevant as concerns environmental issues. The new equipment for single-crystal and powder structural analysis allowed the team to expand their services in the field of chemical crystallography rendering the JANA system suitable for automatic structure-solving.

2. Strengths and Opportunities

With the acquired new equipment, the team is in a very god position to maintain and strengthen its leading role in crystallography.

3. Weaknesses and Threats

None

4. Recommendations

The strong position of the team should be further strengthened by accepting more students to work in the lab as bachelor, master, or PhD candidates. The team should also make an effort to cooperate more closely with the teams of solid-state physics, chemistry, and materials science of the Institute of Physics, in particular in the field of magnetic materials.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The team plays an important role internationally in method development for resolving complex crystal structures. The versatility and complementarity of method development and state-of-the-art equipment is a positive asset. The structure determination with electron diffraction, suitable for tiny crystals not available as large samples, is but one example.

Declaration on the involvement of students in research

The team plays a pivotal role in spreading their in-depth knowledge of various aspects of crystallographic structure determination and method development. The list of activities in this respect, organizing ad-hoc workshops in Prague or participating in international conferences as invited or plenary lectures, is impressive. On the other hand, the list of students actively involved in research is not very long (only one bachelor, master, and PhD defense each during the period 2010-2014). Currently, only two PhD students are part of the team. This might have to do with the nature of the field of crystallography being focused on structure determination. The activities of the team in establishing links between crystal structures and physical properties, in particular of magnetic materials, are encouraging.

Declaration on societal relevance

Members of the team serve the scientific community in various different functions, e. g., as editors of international peer-reviewed journals or as members of both national and international advisory boards. Members of the team have presented public lectures, for instance, on “The beauty of crystals” at Charles University on the occasion of the Year of Crystallography in 2014. The team appears to be well aware of the societal implications of their research, as discussed in the context of structure determination of uranium-based crystals.

Declaration on the position in the international and national context

The group maintains a highly recognized status on the international level and is a leading team in the field of crystallography in the Czech Republic.

Declaration on the vitality and sustainability

With the new equipment acquired in 2015, the team is expected to maintain its strong position. The team should tighten the links to and establish close collaborations with the other departments of the Institute of Physics working in solid-state physics or chemistry.

Declaration on the strategy and plans for the future

The plans for the future are convincing. Establishing the laboratory ASTRA (Advanced STRucture Analysis) with most modern equipment for single crystal and powder diffraction, sample preparation for electron microscopy, and electron diffraction experiment at variable temperatures, will be a great asset for the future development, as is the further method development leading to JANA2016.

Evaluation of the Team No. 5: Magnetics and Superconductors

1. Introduction

The team comprises three groups. The theory group focuses on electronic structure calculations using dynamical mean-field theory approaches for materials with strong electronic correlations where the more traditional density-functional methods fail. Associated with the theory group is the far-infrared magnetospectroscopy (FIRM) laboratory working on vortex dynamics of superconductors. The laboratory of magnetic transition-metal oxides has its focus on thermoelectric materials, spin-state transitions in cobalt-based perovskites, and oxide nanoparticles such as La1-xSrxMnO3. The high-pressure laboratory investigates magnetocaloric materials such as Ni2MnGa under hydrostatic pressure. Determination of the temperature-pressure phase diagram is essential for finding the maximum magnetocaloric effect.

2. Strengths and Opportunities

The team has at its command state-of-the-art facilities for crystal growth and material characterization as well as advanced theoretical tools to make significant contributions to the understanding of the complex physics of correlated electron systems.

3. Weaknesses and Threats

The research topics are rather diverse, which hinders collaboration. Such collaboration could lead to more focused investigations of fewer materials of choice given the scope of the various experimental methods at hand.

4. Recommendations

The cooperation between experiment and theory should be strengthened by uniting forces to focus more strongly on materials that exhibit new and/or unusual properties and at the same time are challenging for theorists, as, for example, the recently discovered iron-based superconductors that exhibit an intriguing interplay of magnetic order, structural order, and superconductivity. This is not meant as a recommendation to enter this field, since it may be too late to jump on the bandwagon. The recommendation is rather to keep the eyes open to seize (or even generate) future opportunities as they come along.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The research of the team is generally of high quality and is based on the strong expertise of the various experimental methods employed.

Declaration on the involvement of students in research

The activity of the team in this respect is clearly visible, with five PhD defenses in 2010-2014. However, given the size of the team, this number could be even larger. Only two bachelor and one master theses were defended during the above period. Members of the team have taught courses in master-degree curricula at the Czech Technical University in Prague and the University of Chemistry and Technology.

Declaration on societal relevance

Team members have regularly participated in reviewing manuscripts for international journals and also contributed to outreach activities.

Declaration on the position in the international and national context

The theory group addresses a variety of issues in correlated electron systems such as superconducting iron pnictides, often in international collaborations, and has a good international standing. The two experimental groups and the FIRM lab are also internationally visible, in particular in the area of transition-metal oxides and thermoelectric as well as magnetocaloric materials. There seems to exist, however, a trend to avoid “hot topics” in the field, such as the issue of magnetically mediated superconductivity, which is in fact the most prominent and heavily debated link between superconductivity and magnetism.

Declaration on the vitality and sustainability

The age distribution of the team members’ age is well balanced, with a peak in the age group 25-30 years indicating a cohort of doctoral students and postdocs, and another peak for the age group >70 indicating the active participation of senior scientists. The five-year age-group bins in-between are homogeneously populated with one or two scientists each.

Declaration on the strategy and plans for the future

An overarching strategy to tackle most prominent problems in the field of superconductivity and magnetism has not been clearly spelled out in the written report. Rather, the plans for the future comprise a straightforward extrapolation of the present activities. The planned cooperation with the team working on semiconductors to determine electron effective masses in GaN thin films with cyclotron-resonance measurements is appreciated.

Evaluation of the Team No. 6: Thin Films and Nanostructures

1. Introduction

The team consists of five groups working on various topics centred on the characterization and functionalities of nanostructures.

- **Nanosurf Lab**: High-resolution AFM/STM images with functionalized tips establishing, inter alia, a fundamental correlation between the tunnelling current and the chemical bond; chemical identification of individual atoms in nanostructures and on semiconductor surfaces by combined AFM measurements and DFT modelling; boron and nitrogen doping of and H adsorption on graphene.
- **Molecular Transport group**: Elastic and inelastic transport in alkanes with highly-conducting Au-C links.
- **Laboratory of Functional Nano-Interfaces**: Enabling nanocrystalline diamond for the use as field-effect transistors or chemical sensors employing impedance effects.
- **Nanocrystalline Silicon for Nanophotonics**: Silicon nanocrystals for optoelectronic applications; photonic structures for enhancing light extraction, e. g., diamond photonic crystals.
- **Silicon Thin Films and Nanocharacterization**: Formation of ordered crystalline Si nano-objects at low temperatures compatible with the CMOS process temperature limits; growth of Si nanotube.

2. Strengths and Opportunities

The team, which has a long and successful tradition in the field of amorphous and nanocrystalline materials and which was founded by Jan Tauc, has in the past years widened its scientific scope and has become once again an internationally leading team in the area of characterization and functionalization of nanomaterials. The blend of materials and experimental techniques is well chosen to keep a position at the international forefront of research. The team has taken full advantage of the possible synergies between the research topics of different groups, e. g., in the development of diamond-based photonic crystals.
This research is in the mainstream of world efforts and is conducted in a very competitive way. Therefore this group has always the potential to make significant scientific breakthroughs.
The research is well supported by the available team expertise and by their infrastructure, and includes both fundamental as well as applied aspects. The effort to protect their intellectual property has to be very highly appreciated.
The age structure of this team is very good in terms of assuring the proper knowledge transfer and professional growth of the future high quality research personnel. The quality of their publications is on average internationally excellent and in many cases world leading. A high ratio between the numbers of journal and conference publications (about 3), which is better than for many similar teams, confirms their dedication to high quality research.

3. Weaknesses and Threats

None

4. Recommendations

The panel encourages the team to continue its excellent work while also taking particular care to protect its intellectual property.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The quality of the research of the groups is generally very high, in a number of cases excellent. Some of the results have been obtained in international collaborations or with external partners.

Declaration on the involvement of students in research

The team has a very convincing record of student participation in research, with five Bachelor, six Master, and nine PhD theses defended in the time interval 2010-2014.

Lectures at national universities were given by five team members (Charles University, Czech Technical University, Technical University Liberec, and Brno University of Technology). Internationally team members have conducted a series of academic activities in France, Netherlands and Canada.

Members of the team have served on PhD committees.

Declaration on societal relevance

The team documents in an impressive list the services delivered to the scientific community and the general public.

Members of the team have contributed to science and research popularization, including numerous media interviews and activities at the high school level to present their research. Participation in the Day of Open Doors within the Week of Science and Technology is also noted.

Members of the team have served on Czech and international project evaluation and project review panels, advisory boards, editorial boards of scientific journals, organization and program committees of international conferences or workshops, and have acted as chairpersons of international conferences or workshops. Last but certainly not least, members of the team have acted in various committees and councils of the Czech academy of sciences.

The work of members of the team in popularizing their scientific field and even beyond is noteworthy. A nice example is the book Luminescence at Home, in Nature and in Laboratory (in Czech) by I. Pelant and J. Valenta.

Declaration on the position in the international and national context

The team has generally a strong international visibility, some groups of the team have reached and maintain a position of international leadership. The team has established very strong and successful collaborations at the national level. Internationall collaborations are with colleagues from Europe, Canada and Japan.

Declaration on the vitality and sustainability

This is one of the largest groups of the Institute of Physics, with 43 researches. The age structure promises a very vital and dynamic development for the near future, with 28 researchers being younger than 30 years. This assures proper knowledge transfer and development of new highly qualified personnel, and guarantees continuing and further development of its current research activities.

Declaration on the strategy and plans for the future

The plans for the future comprise a convincing blend of continuation of the successful work of the past and exploration of novel paths to push forward the frontiers of science. Both are well thought out. They are inspired by, and based on, current research

excellence. Furthermore, the plans include further development of industrial contacts, a fact that should be highly appreciated.

Evaluation of the Team No. 7: Optical Materials

1. Introduction

The department of optical materials (DOM) is a relatively large entity within the IOP. In total the team registers over 40 FTE's in 2014.This personal force is distributed over several branches, named in the report are the Laboratory of luminescent and scintillation materials, the Laboratory of diamond thin films and carbon nanostructures, the Laboratory of electron spectroscopy, the Laboratory of optics and photovoltaics, and the team on theory and modelling of phase transitions. Altogether the department demonstrated a wide range of scientific and technological activities with a large number of publications. It is renown in the international context, and has strong interactions with universities and other institutes.

2. Strengths and Opportunities

The special strength of the department is an active interplay between the different branches, leading to synergies between more technically oriented laboratories and theory and diagnostics groups. Technology wise a continuous effort is successfully improving the instrumental capabilities, as well in the machinery for the production of crystals, nanostructures and diamond films, as for the diagnostics.

3. Weaknesses and Threats

There is no remarkable weakness to mention. As an indicator the ratio between scientists and other employees might signalize a gradual weakening of the technology part. This, however, goes along with a positive development in the age structure over the last years.

4. Recommendations

The strategy of the department depends on a good balance between technical capability and scientific results. The history and the future plans well reflect this, by continuously improving the technical equipment. This should be accompanied by ensuring a high quality technical personnel for the future.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The results give a remarkably positive picture on the strength of the department in different fields. The report includes 10 patents, demonstrating the technology branch of the team, and a number of high quality scientific papers in high impact international journals like Journal of Physics and Physical Review Letters. These results are widely distributed, reaching from material science, e.g. the developments for solar cell technology towards scientific applications as e.g. the development of detectors for international collaborations. In most of the publications the role of members of the department is well visible. As must be expected based on the overall more technological direction of the department, the average impact values are not overwhelming, but balanced by the outputs in patents.

Declaration on the involvement of students in research

There are a reasonable number of students working in the department, and their contribution to the scientific output is demonstrated. 13 PhD students defended their

thesis during the reporting period. In addition a good number of undergraduate students were active in the teams.

Declaration on societal relevance

A fair number of the scientific team members give lectures at surrounding universities and are actively contributing to scientific education of students within the teams. In addition to this the impact through patents and cooperation with industry has to be mentioned.

Declaration on the position in the international and national context

The department has a large number of collaboration projects on the national and the international level. It is participating in European networking at different levels. Worth mentioning is the cooperation both within the Czech Republic and internationally with industrial partners, leading to common patent applications. It can be stated that the department has a strong reputation nationwide and internationally.

Declaration on the vitality and sustainability

During the reporting period the department has continuously improved the quality of equipment, and also adjusted the direction of research. The strategy of personnel development seemingly has changed the age structure by adding younger people to the team. In the balance between technical and scientific staff the ratio of the latter has increased over the years, so far without negative input to the technical basis of the laboratories.

Declaration on the strategy and plans for the future

The plans for future development are very clear and well directed. Strong accent is put onto the further improvement and innovation of equipment, motivated by the demands of also the more scientific involvements in research. This strategy of the different laboratories within the institute is well established, and aims in particular on a further strengthening of the national and international collaborations. A number of Horizon 2020 proposals demonstrate the vitality beyond the already existing projects.

Evaluation of the Team No. 8: Magnetic Nanosystems

1. Introduction

The present structure of the team results from a reorganization in 2012. The team comprises two subgroups working on rather disjunct topics, i. e., on magnetic materials and magnetic films and nanostructures (MNS group), and on classical and quantum turbulence and electric activity of helium (SF group). The MNS group operates, together with the Charles University, two major experimental facilities.

2. Strengths and Opportunities

The experimental facilities jointly operated with groups of the Charles University (JLMS - Joint laboratory for magnetic studies, and JLLT - Joint laboratory of low temperatures) present a major asset of the MNS group. The “age gap” of the team between 40 and 55 years offers the opportunity to redirect and focus the research towards internationally competitive topics of research.

3. Weaknesses and Threats

The small number of team members in conjunction with the broad range of research topics makes it difficult to position the team as an internationally recognized player.

4. Recommendations

Given the small number of team members, the range of research topics is rather broad, even within the two groups of the team. The team presents an impressively long list of articles in journals with an impact factor. It is recommended to consider focusing the research topics to enhance the national and international impact of the research. Also, the collaboration with other teams of the Institute of Physics working in condensed-matter physics on related subjects, e. g., magnetism and superconductivity, or nanostructures should be intensified.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The MNS group has published a large number of papers in the field of magnetic materials and magnetic nanoparticles, and recently also on certain aspects of carbon nanotubes and graphene. As to magnetic materials, a focus has been on 3d/4f and 3d/5f compounds and alloys, where the group has an international standing. Also, the research on magnetic films and bilayers is interesting, demonstrating for instance a strong exchange bias in UO_2/Fe_3O_4 bilayers. Magnetic nanoparticles have been synthesized and investigated towards the application in cancer theragnosis.

The SF group has focused on classical and quantum turbulence in normal and superfluid ^{4}He and ^{3}He/^{4}He mixtures where it has acquired a very good international standing. This is largely due to a close collaboration with L. Skrbek of Charles University who is an internationally recognized expert on turbulence and related subjects.

One has to keep in mind that the team was formed in its present structure in 2012, just a few years back. In view of this fact, the research output in terms of publications is very high. Furthermore, both MNS and SF groups are responsible for the two major facilities JLMS and JLLT. The JLLT activity also entails the He liquefaction services for the whole Institute of Physics.

Declaration on the involvement of students in research

The MNS group is quite active in recruiting students for bachelor, master, and PhD theses. In view of its smallness, the SF group also does a good job in integrating students for master or PhD theses, with three Bachelor, six Master, and four PhD theses of the whole team during 2010-2014. Several members of the team take an active part in teaching at Charles University.

Declaration on societal relevance

The research team intensively participates in popularization of science at the local, national, and international levels as detailed in the team report. Many members of the team have accepted additional duties serving as referees of international journals are members of review and evaluation boards.

Declaration on the position in the international and national context

While the team appears to be well recognized on the national scene, the small number of team members makes it difficult for the team to acquire a leading position internationally although in some cases this was achieved. In general, the work certainly is internationally competitive. It is noteworthy that the team has a number of international collaborations where in the majority of those collaborations it certainly has a large share of the research conducted.

Declaration on the vitality and sustainability

The team has demonstrated its vitality by performing competitive research projects during the period of restructuring. The team members are fully aware of the difficulties they are facing in view of the limited personnel resources, but are eager to exploit the opportunities of the future, for instance by applying for third-party funding.

Declaration on the strategy and plans for the future

The report has shown that the team is fully aware of several points mentioned above and presents a number of ideas for a coherent strategy for the future, for instance profiting from the expertise of the SF group to perform measurements of magnetic systems at very low temperatures. The plans to exploit the recently installed magneto-Raman confocal microscope operating at two excitation energies for the research on magnetic nanoparticles is expected to further enhance the international competitiveness of the team.

Evaluation of the Team No. 9: Dielectrics

1. Introduction

The team focuses on research of insulating or semiconducting materials for which the frequency dependence of the dielectric and/or conductivity functions can be probed by capacitance, waveguide or optical techniques. The range of materials investigated is rather broad and includes liquid crystals (new compounds synthesized by the Insitute of Chemistry of the Czech Academy), ferroelectrics ($Ba(Zr_{0.5}Ti_{0.5})O_3$, multiferroics ($BiFeO_3$, $EuTiO_3$, $Eu_{0.5}(Ba,Sr)TiO_3$, $Ca_3Mn_2O_7$, $Pb_2Fe_2O_5$, and others), piezoelectrics, low-loss materials, composites (PET polymer with carbon nanotubes) or nanostructured semiconductors for photovoltaic applications (CdS, TiO_2, ZnO and Sb-doped SnO_2 nanoparticles). The range of experimental techniques is rather broad and includes including broadband dielectric, infrared, time-domain THz, Raman and neutron spectroscopies, and is supplemented by theoretical and modelling approaches.

The research of the team is being carried out in four groups: Terahertz and ultrafast spectroscopy, Liquid crystals, Dielectric and phonon spectroscopies, and Ferroelectric and piezoelectric materials.

2. Strengths and Opportunities

The team has a very good internationally recognized research record and is a leading group with respect to ferroelectrics and multiferroics, and other materials. The team takes full advantage of its opportunities and appears to be very well organized.

3. Weaknesses and Threats

None

4. Recommendations

Please keep up your very good work!

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The results obtained by the group are internationally competitive, in a number of cases world-leading. Several excellent papers were obtained in large collaborations, e. g., the two papers published in Nature 2010 and 2013 had 23 and 28 co-authors from about ten institutions, thereof two and three from the team, respectively. This shows simply that the team has is positioned among the top groups internationally and collaborates with other top groups worldwide.

Declaration on the involvement of students in research

The involvement of students in the team led to one Bachelor and one Master theses defended in the time interval 2000-2014, and nine doctoral theses. Given the size of the team, this is a rather small number. However, two PhD theses defended in 2015 already and six being in progress indicate that the number is growing. Five members of the team serve as members of field councils of doctoral studies and another five members deliver regular semester courses for undergraduate or postgraduate university students. In addition, several other team members have been occasionally invited to read short lecture sequences for students of national or foreign Universities.

Declaration on societal relevance

The team is strongly engaged in numerous science outreach activities comprising lectures and seminars for general public, interviews for newspapers and broadcasting stations, and publication of popular articles. Many team members have accepted additional duties serving as referees of international journals and/or are members of editorial boards. Membership on Czech and international review panels, evaluation or advisory boards, also of international conference series, is another activity. Finally the team has organized a number of international conferences and workshops

Declaration on the position in the international and national context

The team has a very high standing internationally with a high degree of recognition and, in a number of activities, leadership.

Declaration on the vitality and sustainability

The team is among the largest of the Institute of Physics and has a well-balanced age structure, with eight members below 30 years and four to five members in each of the five-year bins between 30 and 50 years of age, and two to three members in the bins above. The team is well aware of its assets and has a clear view of its opportunities and how to profit from those.

Declaration on the strategy and plans for the future

The plans for the future are very detailed and subdivided into the sections “Intended developments in the current research subjects” and “New subjects and challenges” with several entries each described briefly. In addition, the high-risk high-gain project “Structured dielectric materials with tunable magnetoelectric properties” to explore possible metamaterials is proposed. These elaborate plans demonstrate the vivid strategy and clear vision of the team.

Evaluation of the Team No. 13: Microscopic theory of many-particle systems

1. Introduction

The team consists of two groups working on condensed-matter theory. The larger group focuses on electronic properties, e. g., the impact of strong configurational disorder, electron correlations and time-dependent excitations on the electronic structure, low-temperature transport, magnetic and thermodynamic properties of metals, alloys and semiconductors. The smaller group addresses non-standard collective, critical and out-of-equilibrium phenomena in macroscopic statistical and thermodynamic systems with interdisciplinary outreach.

Both groups use and develop advanced analytic and large-scale numerical methods. The subjects range from electronic-structure calculations of random alloys, magnetic properties of metals and semiconductors as well as spintronics applications of these materials to strongly correlated such as heavy-fermion systems, actinide compounds, transuranium elements, and cold atoms in the first group; and from physics of topologically disordered matter, glasses or granular assemblies and spin glasses to spectral and localization properties of these random graphs. Random graphs have also been applied to phenomena beyond the realm pf physics, such as modeling of economic and social processes.

2. Strengths and Opportunities

The team has a long-standing tradition on CPA calculations to determine electronic structures of materials and on non-equilibrium Keldysh formalism to investigate dynamic and transient phenomena. The team has collaborated with the experimental team on spintronics, which is a nice example of inter-team collaborations within the Institute of Physics.

3. Weaknesses and Threats

The age structure of the team, in particular the lack of young scientists, is regarded a severe handicap for the future development.

4. Recommendations

The colleagues working in theoretical condensed-matter physics in this and also other teams should consider strengthening their ties, since inter-team collaborations were not clearly visible in the written documents. A possibility might be that the theorists join forces and form a condensed-matter theory center which might eventually even lead to a theoretical physics department.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The results of the team are generally well recognized nationally and internationally. A nice example is the joint experimental/theoretical review article in Rev. Mod Phys.

Declaration on the involvement of students in research

Two Master and three PhD theses with topics of the team’s research projects were defended in the time interval 2010-2014. Members of the team have taught at Charles University on Correlation Effects in Solids and, on a regular basis, Thermodynamics and Statistical physics.

Declaration on societal relevance

The work of the group on statistical mechanics clearly reaches beyond the realm of physics. It was not clear from the written documents whether the team has entered discussions or even collaborations with colleagues from economics or social sciences. Direct scientific interactions with colleagues working in these fields might be an advantage. Apart from this direct scientific link, the team is engaged in outreach activities. In addition, team members have served on Czech Review Boards, on Editorial Boards of international journals and conference committees.

Declaration on the position in the international and national context

The work of the team is well recognized internationally. J. Kuneš, a new member of the team, received an ERC Consolidator Grant.

Declaration on the vitality and sustainability

The age structure of the team is rather unbalanced with only three team members being below 50 years of age. This is a serious drawback for the future development.

Declaration on the strategy and plans for the future

Here the team has presented an adequate mix of continuing of current projects and starting new incentives in the two groups, e. g., quantum phase transitions and a stronger focus on nonequilibrium phenomena. Intensifying the collaboration on spintronics with experimental colleagues by searching, characterizing, and understanding new materials is a good example of a successful research strategy. Similar experiment/theory collaborations are encouraged for other subjects as well.

Evaluation of the Team No. 14: Laser-matter Interaction and Chemical Physics

1. Introduction

The team since many years has a high visibility on the national and international level. The world-wide activities leading to this reputation were pursued in international collaborations around world-leading facilities like the FLASH XFEL at DESY in Germany and the LCLS XFEL in the US. World-wide recognition was gained in particular also in the collaborative effort with the Institute of Plasma Physics ASCR through the research program at the PALS laser facility. Through this activity the research was embedded in the European Laserlab-Europe initiative, which was also a key promoter to start the ELI Beamlines project in Prague. One of the outputs of the PALS research was to establish a very powerful laser-driven XUV source, and source of intense ion bunches which can be used as a quasi-in-house facility. The scientific and technological program is centred around the interaction of these sources (internal and internationally) with matter, ranging from elemental solids to biomolecules and optical devices. The team is also active in the direction of the development of compact FEL sources for industry, partly making use of the existing facility at Prague.

2. Strengths and Opportunities

The strong background of the team and the availability of outstanding experimental conditions as well in-house and through long-standing collaborations with other world leading facilities guaranties the basis for top-level research. The additional use of the upcoming ELI facilities in Prague will enhance this position. The team has also majored a wide scope of activities from basic science to technical developments. The age structure of the team of a total of around 27 persons has developed during the evaluation period towards a well-balanced mixture of young and middle age scientists and experienced and still very active senior researchers.

3. Weaknesses and Threats

There is no visible weakness of the team. The team will have to maintain its individual top-quality profile within the fast-moving developments around the ELI project. Using the existing basis this should not be a threat, but rather bring additional opportunities.

4. Recommendations

With the given high quality research in the team, an important role for the next years should be to stabilize a strong in-house scientific work-force, which will be a key factor to warrant a continuous connection between the institute itself and other Czech research teams and the ELI facility. The continuation of the PALS laser activities, supported by the Institute of Physics and the Institute of Plasma Physics, will be vital for this process.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

Many of the results were published in top-quality international journals, including Nature, Phys. Rev. Letters, Optics Letters. The results are covering activities between x-ray and ion-bunch generation, plasma physics, warm-dense matter physics, and laser induced chemistry. The visibility of the team members in these publications is well established. Several of the experiments were carried out at the own facilities. Within the larger collaborations at FLASH and LCLS the role of the team members is also well documented.

Declaration on the involvement of students in research

Within the evaluation period 4 bachelor students, 6 master students and 3 graduate students finished their studies and defended the results

Declaration on societal relevance

Team members are very active in teaching at universities. They are members of many national and international science boards, serve as journal editor, and also contribute to a number of outreach activities.

Declaration on the position in the international and national context

The particular quality of the scientific output of the team is the strong role within international cooperations. This is true as well for the research performed at external facilities (FLASH, SCLS, ELETTRA etc.) as also for research projects at the PALS facility, which were attracted through the activities of the locally responsible scientists. This proofs the fact that the team in the national and international context has a leading position in several subjects. The contributions towards future x-ray light sources in collaboration with industry (Including Zeiss, ASML), and research institutes (DESY,MESA+) is remarkable in the same way.

Declaration on the vitality and sustainability

The team has demonstrated vitality and sustainability in an outstanding way over the last years. It works at the frontier of technology and science, and has successfully adapted changes in the research program according to the latest developments.

Declaration on the strategy and plans for the future

The working plan for the future represents a continuation of successful research topics concerning technological developments of novel sources for x-uv, x-rays and particle bunches and their scientific application. The program is well structured and justified.

Evaluation of the Team No. 15: Laser Development and Applications

1. Introduction

The activities of this team started basically at the beginning of the evaluation period with the large scale project HILASE. Building on experience gained from the PALS project the team was successful to create an outstanding laser facility. In contrast to the PALS and also ELI activities the central idea was to create a system with high average power at smaller pulse energies. Such a system is very well suited to promote a platform for science and technology developments. The project over the evaluation period was well meeting milestones and time plans.

2. Strengths and Opportunities

Starting from an already well established placement within the international laser community, the team attracted both well-educated and experienced members from IOP and the surrounding institutes, and high-level international scientists from all over the world.

3. Weaknesses and Threats

There are no threats or weaknesses appearing, as documented by the high success rate. The science program is aiming to start operation ahead of the ELI project, which will give a good opportunity, together with the activities around the PALS project, to act as a national seeding source for the research and technology at ELI. This will be an additional important task to ensure an active involvement of Czech researchers together with the international centre.

4. Recommendations

Looking at the numbers of students involved in the work of the team it would be advisable to increase their number, aiming at the future strengthening of the laser science in the Czech Republic. This was not possible on a large scale, due to the effort needed to succeed with the preparation of the new infrastructure. In the next years there should be room for more teaching activities.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

In view of the strong involvement of all team members in the technical work of the new laser project the number and quality of publications is remarkable. Within the evaluation period, following the history of the project, the number and quality of publications are continuously rising. The visibility of the team members is very high, which is also a result of a very autonomous research structure.

Declaration on the involvement of students in research

The number of PhD theses defended over the evaluation period was 4 students. As remarked also in the recommendations, at the present stage this is already a good number, but not fully reaching the expectations for the size of the team. This is due to the very dynamical - highly successful - start of the project, but should be altered in the future.

Declaration on societal relevance

The outreach to national commercial partners has been very successful and represents one of the outstanding achievements of the team. This has also rewarded with important grants in this direction. The team is also increasing the activity in teaching at the

surrounding universities during the last two years. Open-day activities and other outreach programs towards younger students help improve the visibility.

An important indicator of the relevance is also given by a number of workshops and conferences organized by the team members.

Declaration on the position in the international and national context

From the beginning of the HILASE project the team was very well embedded and recognized in the national and international context. This is true as well for the scientific community (CLF, IOQ, CNRIFN, JAERI, KAERI and others) as for industrial partners (Skoda, TRUMF, Mitsubishi, Airbus and others). Publications in cooperation with groups from Japan and other countries demonstrate the active involvements. The novel architecture of the laser systems guarantees a visible position in the forefront of laser science.

Declaration on the vitality and sustainability

The HILASE project is on a good way to become a national and international focus point of activities for laser developments and applications. The positioning in the direction of high repetition rate, medium energy and high power levels, fills an important niche in between of typical laser system in university level laboratories and the highest energy and power systems at ELI or –in house- as PALS. The team has a very high quality and an optimal age distribution.

Declaration on the strategy and plans for the future

Scientific programs are already started and can be expected to yield top quality results, due to the novelty of the laser performance. With the new, already approved project HiLASE CoE a superb situation to attract further funding in the coming years has been created. The strong engagement of local and international industrial contacts warrants high quality contributions in the technology sector.

Evaluation of the Team No. 16: ELI Beamlines

1. Introduction

The team “ELI Beamlines” has an utmost important role in connection the international activities at the European Centre “ELI Beamlines” to the national science community inside and outside of the ASCR. During the evaluation period, which means long before the ELI centre will become operative as a facility, the team has already come up to these expectations by forming an international team and achieving high ranked output.

2. Strengths and Opportunities

The team is directly participating in the international effort to build a world leading laser facility beyond present technology standards. During the evaluation period it has already demonstrated ability to make optimal use of this situation. The work is fully embedded in industrial and scientific networks internationally and on the international scale. This will even increase when the ELI centre becomes operative.

3. Weaknesses and Threats

There is no visible weakness.

4. Recommendations

In view of the importance for the Czech science community, the team should enhance efforts on teaching and education. The interaction with universities should be increased, as soon as the load of machinery development will allow for it.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

Already the quality and number of results is outstanding, measuring up to the expectations of a team strongly connected to a pan-European Mega-Project. In many of the publications members of the team are leading authors.

Declaration on the involvement of students in research

There are many students involved in the work of the team, already documented in publications. Due to the present phase of the project, students are also strongly involved in technical developments.

Declaration on societal relevance

The team is very active within the international networking around ELI, and also in the direction of contacts with industry. The positioning of ELI automatically brings the team into a “light-house” position, which is filled well by the members.

Declaration on the position in the international and national context

The team is fully recognized and assumed a leading position in the international community. In the national context it provides a crystallization seed for activities.

Declaration on the vitality and sustainability

There is no doubt about the vitality and sustainability of this enthusiastic team. For many years to come, ELI-Beamlines will be a world-leading facility, and this team is a substantial part of it.

Declaration on the strategy and plans for the future

Strategy and plans for the future are to a high degree given by the time-scale of ELI.

Evaluation of the Team No. 17: Experimental particle physics

1. Introduction

The experimental particle physics team has an international reputation of excellence which is based on a well-chosen spread of activities. This spread encompasses scientific research and detector development for that research.

It's primary output, and its primary success in the reporting period, which it rightfully owns along with all who participate in energy frontier research at the LHC at CERN, is arguably the most important discovery of contemporary physics, namely that of the scalar boson(s) of the Standard Model, and thereby the final confirmation of a number of earlier Nobel Prizes in the 20th century concerning the seminal role of the Higgs mechanism in physical law. It is to the credit of Czech physics, steered through the direction of the Institute of Physics, that the Czech Republic stands alongside all participants world-wide in equal ownership with equal distinction of this major scientific discovery.

The submission of the team in respect of its work as important members of the ATLAS collaboration to this review amply demonstrates its distinction alongside its international collaborators. It quotes "operation, maintenance, and upgrades of the inner tracker [2] and Tilecal [3], R&D for future high luminosity upgrade of those two detectors, physics analyses of the data, and computing". The spread of such activities cover underpinning technologies of charged and neutral particle detection, the drive for as much precision as possible in measurements, the data analysis which produces these measurements, and the development and sustenance of computing techniques which enable these measurements, on all of which all physics in ATLAS depends.

The team has also brought its experience in antiproton-proton interactions at the DØ experiment at Fermilab to its ATLAS work. This has included important work at the Fermi energy scale concerned with quarks and gluons in respect of their fundamental properties as Dirac fermions and vector bosons respectively in non-abelian QCD.

In parallel with this experience, the team has maintained its strong involvement in electron-proton physics with its exploitation of the unique data-set which it obtained throughout the life of the H1 experiment at HERA at DESY, Hamburg with its international collaborators. The Czech groups, and in particular the team at the Institute of Physics, have the distinction of having been centrally active in this electron-proton physics at HERA since its inception in the mid-1980s. The perspective of HERA, which is now universally appreciated, is well described in the submission of the group to this review, namely a unique mix of precision physics across the whole gamut of the Standard Model at the Fermi energy scale. The output in the reporting period of this work in the institute during the latter stages of the analysis of HERA data has been therefore of "textbook" pedigree. These measurements alone quantify the space-like unification of electromagnetism and the weak -interaction, use the electroweak probe in the form of the incident high energy electron interaction to measure proton and photon structure often with a precision and scope which is unmatched anywhere, and elucidate uniquely the chromodynamic structure of the hadronic interaction at high energy.

In this reporting period, the team has also judiciously placed itself at the immediate centre of neutrino flavour physics by making essential and important contributions to the NOvA experiment at Fermilab and the Ash River remote detector ready for the beginning of NOvA's imminent data-taking period. This positions the neutrino group in the team optimally in respect of the next round of neutrino oscillation measurements, because present measurements indicate that the mixing angle between heaviest and lightest flavour is "large" and "neutrino factories" are unnecessary. The NOvA experiment will precede the major investment DUNE also at Fermilab, but this time with a baseline to

South Dakota. International consensus is that DUNE is now the right step on a timescale to data-taking after NOvA in the mid-2020s.

The team also has quite some “pedigree” in detector developments which underpin its physics programme. It is a strong contributor to semi-conductor detectors, both strip and latterly pixel, which are at the heart of all contemporary collider experiments. It has made contributions to the next generation of calorimetry with its work on CALICE driven by the possibility of a sub-TeV electron-positron linear collider. It continues to bring expert experience of real-time operation to this activity through its responsibilities for the operation of components in ATLAS. Though (rightly) driven by a major scientific question on an active or a putative experiment, these developments are noteworthy in their own right as cutting-edge R&D achievements.

The team also continues its role as a Tier 2 computing centre within the LHC grid computing project. That it continues to do so is important.

2. Strengths and Opportunities

The team is strong in all aspects of its collider physics. It has a growing involvement in neutrino physics which should be strengthened for the foreseeable future if it is to play as equally a central role commensurate with that which it has and always has had in its collider program. The balance between the two activities is a matter of taste and interest, but should not be let become too asymmetric.

3. Weaknesses and Threats

In the last half-century, experimental particle physics has been indisputably a story of scientific success in Europe, and throughout this period the Czech Republic has been a distinguished part of this story with the Institute as the pivot of Czech involvement at CERN (and Dubna) where is to be found the underpinning technological facilities which sustain experimental particle physics in Europe and beyond.

The future for the team in the next reporting period of this review procedure must continue to be based at the LHC at CERN and in the global focus on neutrino experiments, for which now Europe’s engagement is also more and more being co-ordinated through CERN. To compromise in any way on these aims would be very damaging throughout the next reporting period.

However, particle physics is a long-term, as well as a “big”, science, and appropriate planning is always an issue in the face of on-going measurement and discovery which may lead to a changing scientific landscape. The team has already faced such an issue over its work with the CALICE calorimeter collaboration, which was initiated with the view of an international linear collider (ILC) in mind. The cost of an ILC continues to dog its progress particularly in respect of the possibility of a single national initiative hosting the project, and thus the ILC continues to slip in respect of any reasonable time-scale, perhaps now disastrously so. The team has therefore demonstrated that it can manage its future in respect of such difficulties, even threats, to its R&D work for its future. It must continue be watchful in the future for other such changes, the risks of which are most sensibly mitigated by following closely and influencing where it wishes the European strategy for particle physics.

4. Recommendations

The group is very well placed to deliver outstanding physics throughout the next reporting period. It is therefore in the interests of the excellence of the institute and of Czech

science that it continues to be appropriately resourced to do so.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The output of the team submitted to this review is of unusually spectacular scientific quality, given the nature of the Nobel discovery, the ATLAS group's many contributions to this discovery, and the range and quality of publications from all its experiments which have been led by members of the group.

All members of the Particle Physics team participate in the data-taking of experiments following the procedures for allocating shifts agreed by the collaboration concerned. For each research institute, usually this allocation is proportional to the number of members of the team who sign publications in the name of the collaboration.

Team members have participated in the design and construction of several of the detectors which together constitute their experiment, for example semi-conductor silicon track detectors and calorimeter detectors. The experience which this work brings means that team members then are able to make important contributions to, and take responsibility for, monitoring, slow controls, data quality checks, and calibration of these detectors during data-taking in addition to their pro-rata shift work. This work is essential if the quality of data on which good physics analysis relies is to be achieved and as such is the mark of a strong experimental group in international research. It also is important in that it enables team members to continue to develop personally in some cases internationally recognized expertise in such work, which they are then able to bring to future local and globally collaborative R&D. This in turn thereby enables members of the team to have substantial influence on future international experimental opportunities and their exploitation.

The team operates a computer center in the Institute of Physics. It is mostly used for simulation work by team members working on the ATLAS, ALICE, D0, NOVA and Auger experiments. The work has also included a framework for job processing and tools for data management. Throughout the evaluation period this work has necessitated rapid adaption to a wide variety of frequent changes as experiments improve and develop further their simulation, reconstruction and analysis procedures. Such work is the mark of a strong experimental group in international research.

Team members participated in the data analysis and preparation of publications from their experiments. They are primary authors of 5 of the 31 evaluated publications, one team member is the only author of two papers, 4 papers are based on the theses of the team Ph.D. students, who had major share in the data physics analysis. In other publications the team members made specific expert-based contributions to analyses, for example, unfolding procedures, estimation of systematic errors, and energy calibration. Several publications deal with the performance of detectors for which to qualify as authors, team members made substantial, and often innovative, contributions.

Team members participated in the proposal for the new detector AFP of the ATLAS experiment aimed at diffractive physics at the LHC. They contributed to various aspects of the proposal preparation, for example the formulation of the scientific program which is enabled, the detector design, the mechanical construction of the first prototypes and the management of the project. This project was approved by the ATLAS collaboration in 2015.

Declaration on the involvement of students in research

The group has good students fully engaged in their internationally placed programs. The added value of such international involvement at little or no extra cost to postgraduate education in the Czech Republic should never be forgotten. The beneficial return of such opportunities for all aspects of the future of highly educated personnel with experience on the international stage, scientific or otherwise, is substantial.

Fifteen Bachelor theses and 14 master theses were defended in the evaluation period. The team had 11 PhD students, 4 PhD theses were defended. The PhD students spend significant time at the place of experiments and thus they can contribute effectively to scientific results obtained by experiments.

Declaration on societal relevance

The positive effect of particle physics research on economic development, on education and training, on societal inspiration, and on international influence is very well documented in a number of reports in different G7 nations. The Czech Republic is no exception. The group's existence, its work and its output have been, are, and always must be therefore an essential part of such activities in the Czech Republic.

Declaration on the position in the international and national context

The text herewith in other sections gives evidence as to the indisputably international and national context of this group's work. By definition, experimental particle physics is a discipline which always operates in an international context.

The ATLAS group members of the team coordinate activities of all Czech ATLAS groups from the Charles University, the Technical University in Prague and Olomouc University.

They are members of the collaboration boards of ATLAS, members of EUDET, RD50 and MediPix collaboration boards, and members of the European Committee for Future Accelerators. Within the ATLAS experiment, they are members of the Tilecal calorimeter and the AFP management groups and of the main management group of the pixel silicon tracker. One team member was physics coordinator and another group member is the technical coordinator of AFP project. In comparison with other comparable national contributions to similar international programs, this is above average.

Declaration on the vitality and sustainability

There are no major causes for concern in respect of vitality and sustainability.

Declaration on the strategy and plans for the future

The team has demonstrated its flexibility in adapting its own scientific interest to changes in opportunities internationally for experiments. Its plans are feasible, sensible and prudent.

It perhaps should be encouraged to think "out of the box" concerning how it could create new activity, always with new and additional resource, to pursue more speculative, small scale, experiments either at low energy laboratories (eg rare branching ratio measurements of leptons and hadrons, lepton universality) or even in-house precision measurements of sub-atomic effects in the physics of atoms (may be precision atomic physics or low energy phenomena with newly available facilities at ELI, for example anomalous electromagnetic phenomena). In this respect it is interesting to note how work on electroweak, charged current, Lorentz structure in the Relativistic Heavy Ion and Neutrino Physics team at the Nuclear Physics Institute could be considered as part of a new initiative in fundamental physics in the Czech Republic.

Evaluation of the Team No. 18: Particle physics theory and phenomenology

1. Introduction

The team submitted a fascinating and challenging report of its activities to the panel. The fascination comes because of the clarity of context in its report of the work in string field theory, and because of its approaches to interpretation of long-standing issues related to hadron structure. The challenge comes in respect of its work in Quantum Gravity and the context of “Hawking’s chronology protection conjecture“, for which an expert assessment requires appropriate theoretical depth which is not available directly to the panel. It is however clear from the assessments in Phase I that a group of team members are initiators, if not in absolute terms pioneers (at the level of Godel!), in much of this work, and that this team is recognised globally for it.

The work on phenomenology, which can be more easily assessed in terms of its immediate usefulness, is meritorious because of its closeness to experiment, sometimes even part of experiment. In particular, some of the group seem to work closely with the ALICE experiment at the CERN LHC

In respect of focused expert involvement, but not necessarily still in respect of the activities of a phenomenology group, is the work in the TOTEM experiment. The focus on the classic and very important measurements at the LHC of proton-proton elastic scattering is noteworthy. It is part and parcel of essential measurements at any new energy scale. The expertise of the team in this venture is therefore most appropriate scientifically.

The technology of forward proton detectors which underpins the TOTEM work also is being evaluated in respect of nearly real photon-photon interactions at the LHC. This is timely and interesting work which could lead (as the team says, and if forward detection is sufficiently forward) to new science concerned with gauge boson production.

A noteworthy example of phenomenological work in the team is that concerned with the full longitudinal and transverse structure of nucleons in the form of analysis in terms of Generalised Parton Distributions (GPDs). There is experimental interest in this work, which amounts to “proton tomography”, at present and future lepton-hadron scattering experiments, for example right now in work at the Thomas Jefferson Laboratory in the US and at CERN with the COMPASS experiment, and in the future at the electron-ion/polarised proton collider eIC or eRHIC in the US. Together also with the valuable work concerned with the thorny issues of rigorous calculation in QCD and how it enables progress to a complete understanding of the place of QCD in the Standard Model by improving predictive frameworks and thus accuracy of chromodynamic parameters, this work is of lasting value.

2. Strengths and Opportunities

The burgeoning work in mathematical physics is a highlight of the institute’s international profile. It should continue to be encouraged with a view to adding even more value through the attraction of high quality staff at all levels using external as well as national funding opportunities. One will symbiotically feed the other given what is in place now.

The achievements in chromodynamic phenomenology merit nurture to further application if at all possible alongside new experimental opportunities which are maturing.

3. Weaknesses and Threats

To allude to “weakness” in respect of the work on ALICE, TOTEM and possible future photon-photon physics in the gauge boson energy regime (the Fermi scale) would be wholly inappropriate. Nevertheless there is substantial risk that these activities may not look forward to an optimal environment in respect of the activities begun in 2009 in the theory group. Mitigation may well lie in discussions with relevant experimental teams in and beyond the Institute with the aim of achieving collective assessment of the best way to use available resources.

4. Recommendations

To insure against undue loss of science because of lack of continuity, while at the same time building on growing contemporary success in other research groups as time progresses, there could be rationalisation within the frameworks of future heavy ion physics at ALICE and the Nuclear Physics Institute, and of forward proton elastic and inelastic physics at the LHC and the experimental particle physics team of this institute. For all these activities are of a quality which mean that it would be a pity if the substantial achievements of many years of them in this Institute were not to be taken forward with wherever else similar experimental opportunities already exist and flourish nationally.

The consequences and the exploitation of the important, well established and well respected work concerned with the phenomenology of hadron structure should if possible not be missed in respect of the new experimental opportunities now operating at JLab and at a future electron-ion/polarised proton collider in the US. Both may well be work which could be more appropriately sited in the Nuclear Physics Institute or possibly in any future Hadron Physics work of this Institute.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The team’s work is in general of international interest and significance, the latter meaning that advantage will be gained by theoretical colleagues in respective fields worldwide and that the members of the team will thus continue to be held in high esteem by their global peers.

The published work of the team concerned with string field theory and quantum gravity is placed in the categories of world leading (6) or internationally excellent in a submission of 19 publications. Moreover the publications are single author or are initiated by authors from the team working on these topics.

The phenomenological work is of long-standing importance in respect of outstanding problems in hadron physics for which future experiment will need input if they are to make important measurements. It is also of course of contemporary importance for progress in high energy proton-proton and heavy ion physics at the LHC. However, one team member working with ALICE and two team members working with ATLAS at the LHC are it seems full members of these collaboration in that they have signed about 400 experimental publications in the reporting period from these two experiments. There is no account of the contributions to these two experiments which these team members have made in the written submission by this team, particularly in the forms of responsibilities for the operation of the experiments and of input to any of the listed publications.

Declaration on the involvement of students in research

The number of students at all levels in the team could be larger, but one can always say this about good theory teams.

In the period of evaluation, 8 PhD students graduated after working with the team as part of its research activity. Team members supervised 6 of these students.

The new developments since 2009 in the activities of the team may well restrict candidates to be those who have a particularly strong mathematical background, something which should be born in mind carefully in view of possible career paths other than more theoretical research for PhD graduates from the team.

Declaration on societal relevance

The case in support of societal relevance for a theoretical physics group is more narrowly focused than for experimental research. Nevertheless, it is equally compelling when laid out in respect of the many benefits of a highly educated, mathematically able, cohort in society. The primary requirement is a theoretical group which attracts the most able at all levels. This team is in major part already doing this successfully.

Declaration on the position in the international and national context

The physics accomplished by this team is of international significance without exception, and of international distinction in many new areas.

The team attracted 8 foreign staff to post-doctoral positions in the reporting period, who worked on string field theory and quantum gravity. They were selected in open international competition and funded from national funding agencies.

Declaration on the vitality and sustainability

The theoretical physics work in quantum gravity and in string field theory now offers huge potential for the future, in particular with a view to establishing further a recognised national centre of excellence of “theory for theory’s sake” in the Institute.

With rationalisation, the phenomenological work of the team in the form of continuity of its past distinction in future experimental opportunity could enable new opportunities, albeit most likely in other research teams in the institute or in other Czech research centres.

Declaration on the strategy and plans for the future

The burgeoning work in quantum gravity and in string field theory forms a strong basis with which to anticipate future growth and distinction of the mathematical physics emphasis of the group. The possibilities for future optimisation of phenomenology should be considered in plans for the future.

Evaluation of the Team No. 19: Optical and biophysical systems

1. Introduction

The main directions of the research conducted by this group are focused on research and development of optical materials and systems in micro- and optoelectronic and biomedical applications. This combination of research is well chosen and looks very promising, and is quite multidisciplinary. The research is well supported by the available team expertise and by their impressive infrastructure. The research includes fundamental as well as applied aspects, and their efforts to develop new Intellectual Property specifically in the area of biomedical applications should be highly appreciated, since they have a potential to lead to significant breakthroughs.

2. Strengths and Opportunities

The quality of their publications which are mostly internationally excellent and internationally recognized illustrates quite well the strength of this group. The high ratio between their numbers of journal and conference publications (about 5) is much higher and better than for a typical research group of their size. A further strength is their apparent ability to direct their research towards practical biomedical implementations, which can bring important benefits to the society, while taking care of adequately protecting their intellectual property.

This is a strong group, which has a pragmatic approach to research. It has therefore an excellent opportunity to successfully compete on the global market, where the interest and need for the novel biomedical technologies for diagnostics and treatment is growing fast.

The age structure of this team is good in terms of assuring the proper knowledge transfer and professional growth of the future high-quality research personnel, however attention has to be paid to renew a part of the research personnel.

3. Weaknesses and Threats

No particular weaknesses has been observed in this team, and the Committee sees no threats to its present direction of research

4. Recommendations

Continue this interesting and competitive research, with even more focus on novel biomedical technologies under development, since they have a potential to directly benefit the society.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The majority of evaluated outputs of this team is internationally excellent and some of them are world leading

Declaration on the involvement of students in research

The team is very active in supervising students (currently 8 PhD and 2 MSc) with 2 PhDs graduated during the evaluation period. The team gives regular lectures at local universities and gave two at the international scene in Italy and in Finland.

Declaration on societal relevance

The team is exceptionally active in the scientific activities at the international scene, and also in science and research popularization, including frequent media interviews to present their research. It organizes the Open Days for the public regularly on the yearly basis.

Declaration on the position in the international and national context

The team has established exceptional and successful collaboration at the international and national level, with both academia and industrial partners

Declaration on the vitality and sustainability

The age profile of the team is very good and guarantees continuing and further developing its current research activities.

Declaration on the strategy and plans for the future

The plans for the future and strategy are well thought out and inspired by highly successful current research achievements

Evaluation of the Team No. 20: Physical processes in low temperature plasma

1. Introduction

Since 2010 the team “Physical process in low temperature plasma” of the Department of Low-Temperature Plasma has been focusing on research dealing with physical processes in low temperature plasma sources. The plasma processes were investigated in various PVD (Physical Vapor Deposition) and PECVD (Plasma Enhanced Chemical Vapor Deposition) plasma systems used for the preparation of different types of functional thin films and coatings. The main focus was on the deposition of semiconducting materials for photocatalytic applications, solar water splitting, and photonic applications.

2. Strengths and Opportunities

The excellent research results in the field of deposition of semiconducting materials for photocatalytic applications, solar water splitting by means of new low temperature pulsed plasma sources offer a wide range of opportunities. This technique provides a very high oxide film deposition rate as well as a quite good semiconductor quality.

3. Weaknesses and Threats

No manifest weaknesses or threats have been observed.

4. Recommendations

Focus on the research of low temperature depositions of materials for water splitting applications and other photoelectrochemical or photonics applications.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The team is successful and achieved significant results with high level recognition in the low-temperature plasma community. The quality of the evaluated results is good.

Declaration on the involvement of students in research

There exists a cooperation agreement with the University of South Bohemia on research, teaching activities and supervision of bachelor and master students. The number of students is appropriate.

Declaration on societal relevance

The societal relevance is limited. One lecture for the general public was given at AVCR about the application of low temperature plasmas for the deposition of thin films for medical purposes

Declaration on the position in the international and national context

Collaborations with Germany (University of Greifswald and University of Erlangen) and Russia (Academy of Sciences); in CR with the University of South Bohemia and with Charles University Prague.

Declaration on the vitality and sustainability

The age structure of the team is good and guarantees a continuation and further development of the R&D activities.

Declaration on the strategy and plans for the future

The plan for following years is sound. It foresees to continue with the research of physical processes in the low temperature plasma accompanying deposition of various materials. The main focus will be on the research of low temperature depositions of materials for water splitting applications and other photoelectrochemical or photonics applications. In the period 2015-2017 the team will participate in the TACR project (Technology Agency of the Czech Republic) dealing with applied research of low temperature optical thin film depositions by multi-plasma jet system for large areas of industrial scale. The main target is to develop this plasma source and control properties of deposition conditions to get defined reproducible coatings. The team is further participating in the EU FP7 project HIPPOCAMP (2014-2016) with the characterization of the plasma in PVD-PECVD deposition processes of damping coatings and optimizing the properties of these materials.

Evaluation of the Team No. 21: Plasma-based technologies and analysis of functional nanomaterials

1. Introduction

The team works in two major areas, on physical vapor deposition technologies for thin films and nanostructures focusing on plasma deposition, and on analytical techniques to characterize and investigate these films. The team runs the Center for Analyses of Functional Materials (SAFMAT) and the Center for Functional Materials for Bioapplications (FUNBIO), with the participation of scientists from other departments of the Institute of Physics. Main analytical tools are NanoESCA, EPR, SEN, AFM, infrared ellipsometry, and optical lithography. These laboratories are part of the Roadmap for Large Research Infrastructures in the Czech Republic, and are open for collaborative research projects with other departments of which several examples have been presented in the report.

2. Strengths and Opportunities

The team has a strong technical expertise in thin-film preparation technologies. They collaborated in several projects supported by the Czech Science Foundation: Advanced materials for photovoltaics such as substituted phthalocyanine organocomplexes (with University of Chemistry and Technology, Prague), Novel materials for magneto-optical applications (with Charles University and Technical University of Ostrava), Investigation of point defects in ZnO and their interaction with hydrogen and nitrogen (with Charles University), Detection layers based on composites of organocomplexes and nanoparticles for chemical sensors (with University of Chemistry and Technology, Prague).

3. Weaknesses and Threats

The team sees its primary role in supplying high-quality thin films to various research groups, primarily within the Czech Republic. This is of course a very legitimate and high value role in support of Czech research, development, industrial innovation and commercial exploitation. It bears, however, the risk for the team of losing sight of an overarching and internationally visible scientific research profile. The diversity both of the materials and of the underlying physics with which its present work deals means that to achieve such a research profile requires it to focus its wide-ranging technological expertise on a few interesting materials.

4. Recommendations

The team should pronounce more clearly its own scientific interest, perhaps even initiate its own projects.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The scientific profile and output of the team is somewhat below that of most other teams of the Institute of Physics. The motivation of the team in choosing their materials and technologies in terms of scientific progress is not very well spelled out in the report. Rather, the team apparently regards its mission to prepare thin films by physical vapor deposition technologies according to the needs of the Institute’s departments and other Czech scientific communities. This goal in itself is certainly viable, but from the report it is not clear how in the collaborations with the “customers”, the team is able to establish its

own scientific profile beyond delivering thin films as a service to the project.

Declaration on the involvement of students in research

The team supervised several students in their thesis work; during the time interval 2010-2014, three bacchelor, one master, and three PhD theses were defended. Team members also contributed with lectures to the curriculum of bachelor and master courses at several Czech universities.

Declaration on societal relevance

Team members served on thesis and examination committees at the Czech Technical University, the University of Chemistry and Technology, Prague, and the University of West Bohemia. Research results were presented to the general public focusing on participation in open-door days where the team reports a recent strong increase of interest. The projects SAFMAT and FUNBIO were introduced to the public on radio and press.

Declaration on the position in the international and national context

The team does contribute to the Czech scientific research of materials preparation using plasma technologies, but has very little impact on the international scene. The materials chosen for preparation somewhat reflect the main trends internationally, but there is only little activity or attempt to initiate own projects.

Declaration on the vitality and sustainability

The age structure is rather unique in that 11 members are below 45 years, two between 45 and 55, and 4 above 65 years of age. This age structure, with the great majority of scientists being rather young, could offer the possibility of a dynamic scientific development.

Declaration on the strategy and plans for the future

The research plans are rather elaborate and do suggest that the team may take an active part in several important developments. The team should be aware of their limited resources of personnel and should consider focusing their research on fewer projects in order to obtain a higher degree of international visibility.

Evaluation of the Team No. 22: Classical and quantum optics

1. Introduction

The team “Classical and Quantum Optics” is formed by employees of the Institute of Physics within the Joint Laboratory of Optics of Palacký University and Institute of Physics AS CR. A total workforce of 35 people (including 19 research workers, excluding support staff) is working on a variety of subjects in between of applied optics, quantum optics, statistical and wave optics, and properties of materials and laser technologies. A large number of high-level publications were achieved within collaborations, in particular the Pierre Auger Observatory (PAO) and the Cherenkov Telescope Array (CTA), where the fabrication of important optical subsystems of particle detectors was contributed. But also without these publications numerous high-ranking publications were achieved, which by themselves put the team into an internationally truly visible and leading position.

2. Strengths and Opportunities

The special strength of the team is given by the combination of world leading research in basic quantum optics and a rich inventory of back-ground in technical and applied physics disciplines between the characterization and manufacturing of optical components. With this the team achieved both success in technological developments and scientific research, a truly unique combination of high level scientific output and collaboration with industry.

3. Weaknesses and Threats

There is no obvious weakness visible. The age structure and quality of the personnel, and the collaboration within the Institute of Physics and the university seem to give a stable foundation for the future developments.

4. Recommendations

It will be crucial to maintain the high quality level of the scientist and engineers of the team. For this is might be advisable to invest even more into education in terms of PhD and other students.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The quality of the results is outstanding in national and international comparison. The share of team members to many of the high-index publications is as leading or first authors. The role in the collaborations where authorship in multi-author publications is achieved is well document and of important contribution.

Declaration on the involvement of students in research

Students are involved in several of the publications. During the evaluation period 10 PhD theses were defended as a result of student activities. In addition 10 master theses and several bachelor works were submitted.

Declaration on societal relevance

Due to the strong interconnection with universities many classes were offered by members of the team. Members of the team participated in a large number of popularization activities. Highly visible is the representation of the team in scientific

commissions and panels. A summer school in optics for Czech and Italian high-school Students was organized. The institute is editing the Journal of Fine Mechanics and Optics.

Declaration on the position in the international and national context

The leading position in the national context is marked by the many connections with industry and the strong interaction with the universities and research institutes. Internationally the high visibility of outstanding research is documented by numerous publications and by the well accounted contribution to large collaborations (PAO, CTA).

Declaration on the vitality and sustainability

The high degree of internationalization, driven by in-house experience, is an indicator of the vitality of team. The age-structure is well balanced, and the effort in education assures to keep the team in a healthy structure in the future.

Declaration on the strategy and plans for the future

The plans for the future include a deeper interconnection with other RCPTM groups, the inclusion of optics of nano-objects, quantum correlations in intense fields and multiphoton quantum gates. Approaching new optical technologies like subaperture grinding and polishing the way towards even more industrial/commerce projects will be guaranteed. In addition the involvement in a rising number of EU projects is planned. This strategy will warrant a leading role internally and internationally.

Date: January 20, 2016

Commission Chair: Prof. John Dainton