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: Nuclear Physics Institute 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: Vladimír Wagner, substitute observer Jan Dobeš

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 - Theoretical Physics; No. 2 - Ultrarelativistic Heavy Ions; No. 3 - Relativistic Heavy Ions, Neutrino Properties; No. 5 - Nuclear Reactions; No. 6 - Research with Ion and Neutron Beams; No. 7 - Neutron Diffraction; No. 8 - Dosimetry of Ionizing Radiation; No. 9 - Radionuclides and Accelerators

A. Evaluation of the Institute as a whole

1. Introduction

Nuclear Physics is these days a sub-discipline of physics of unusual depth and scope. Its pedigree, indeed its noble tradition, continues to be a subject of interest and importance, and to lead to new and important technological developments of substantial importance.

It includes

- the physics of nuclear structure and of the dynamics of nuclear interaction in terms of constituent nucleons, in particular the discovery of new, expected and unexpected, isotones and isotopes, such as „high-Z“ and „high-N“ nuclei far from the „stability line“, and superheavy elements, and the mechanisms of nuclear reactions,
- the physics of heavy ion collisions in which the phase diagram of nuclear (hadronic) matter is probed and which includes the dynamics of hot hadronic matter in terms of the degrees of freedom of the fundamental, non-abelian, field theory, quantum chromodynamics (hot QCD and confinement),
- precision measurements of fundamental and of otherwise forbidden or hitherto undetected couplings by means of rare decays of nuclei which constrain the possibilities of new physics beyond the Standard Model of the Universe,
- the application of the above terrestrial laboratory research to astrophysics, and
- an immense range of application related to energy production, medical application, trace technologies, even application in archaeological, historical and relic categorisation and preservation, and more.

This categorization broadly follows, but is not identical to, that of the Nuclear Physics European Collaboration Committee (NuPECC).

The Nuclear Physics Institute (NPI) includes research teams concerned with a broad swathe of subject areas, all of which are important in respect of the above wide brief of “Nuclear Physics” and its applications. This is appropriate given the nature of similar centres worldwide of which this Czech Institute is no exception. It provides a broad and robust foundation on which to base for many years a national centre of nuclear research with distinct and globally recognized expertise and scientific excellence.

The review procedure on which this evaluation is based included not only external assessment of publications and related output, such as conference presentation, outreach, and international visibility, but also attendance at the Institute by the panel of evaluators who together visited for one day in October 2015. At the visit to this Institute, 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 of the Institute and the Council of the Institute, having been made aware of the overall legal framework in which research Institutes operate in the Czech Republic.

2. Strengths and Opportunities

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

The maturity of Nuclear Physics, exemplified in its range of activities, means that Institutes such as this have usually been through many cycles of regeneration and reorganization to meet changing and scientific and societal demands. This usually means that they have the experience and maturity to recognize new opportunities both to develop new and original science and to exploit their science. The NPI is no exception.

The "portfolio" of the NPI's "curiosity-driven" scientific program includes work at the "cutting-edge" of the categorization listed in the Introduction. Its activities concerned with R&D for technological application are significant and important, taking advantage of the international links which scientifically the achievements and reputation of the NPI secure.

It is instructive in assessing the significance and distinction of the NPI to tabulate the material submitted by its teams against each category in the Introduction. In doing so one should stress that assignments in this table are those of the panel based on the material submitted to them in this evaluation.

	Nuclear Structure and Nuclear Interaction	Heavy Ions and Phase Equilibria of Nuclear Matter	Precision measurement of nuclear phenomena and neutrino experiments	Nuclear dynamics for Astrophysics	R&D for Technological Application
Team 1	X	X	X	X	
Team 2		X	X		
Team 3	X	X	X		
Team 5	X	X		X	X
Team 6					X
Team 7					X
Team 8					X

It can be seen that the research work in the NPI has a breadth, as well as the depth mentioned in the submissions, which is noteworthy, desirable, and provides strong evidence for optimism in terms of maintaining and enhancing research excellence in the future. It also contributes in all areas identified by NuPECC.

Further, in all these activities, the submitted material and discussions with the NPI teams by members of the panel indicate considerable scientific leadership and innovation by each team in many of its activities. The consensus of the panel is that these teams continue to contribute strongly to their international research, and that this strength should not be jeopardized.

3. Weaknesses and Threats

Three in-house issues are a cause for concern. They emerge from the submitted material and from discussion with teams. They are

a) in some teams there is an imbalance in staff age profile,

b) a lack of completion of PhD students in the reporting period of this evaluation.

They could be correlated. If not considered carefully soon and any action which is perceived to be necessary not taken, they could also have serious consequences.

4. Recommendations

In view of the above threats and weaknesses in mind, the panel recommends that care and attention be paid to the issue of age profile and continuity of research staff in some teams, including the numbers of students in post-graduate education.

One external issue should continue to be followed carefully. There is substantial dependence of some high quality scientific activity in the NPI on the continuation of, and the availability of, future international facilities, to which already NPI teams have made important contributions both technically in preparation and scientifically in exploitation. However, in at least one case, there have been already severe delays in the original schedule for completion of these facilities. The NPI teams concerned need to continue to watch this very carefully with contingency plans in hand if they are to sustain the excellence of their scientific output.

5. Detailed evaluations

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

The evidence for the quality of the results is to be found in the outcome of the Phase I evaluations and the comments of the Panel which are presented here in respect of the material submitted to the panel by the individual research teams and the discussions of the panel with the leadership of all research teams.

Declaration on the involvement of students in research

All evidence in written submissions, presentations to the panel and discussion confirm the remarks in the recommendations above concerning PhD turn-over throughout the reporting period. There are no major contradictions with the output assessments in Phase I.

Declaration on societal relevance

All research teams are well aware of the importance of outreach, they made this clear in their submissions to the panel and in presentations to it, and they were ready and willing to discuss the context and the nature of it.

The spread of research and development in the NPI includes substantial work focused on direct application which is of immediate value to national well-being in respect of technological application, monitoring, and other exploitation, and therefore to societal relevance.

Declaration on the position in the international and national context

It is clear from the submitted material, its independent assessment in Phase 1, and from discussion with the panel, that there is substantial evidence to support all the statements made by the teams concerning their scientific and technical achievements and to support the comments below concerning the evaluation of individual teams.

Declaration on the vitality and sustainability

Each research team has been considered in relation to vitality and sustainability and the outcomes are to be found in each report below.

The collective sustainability of the NPI is sound. Teams are funded through a number of agencies, both national and international. As already mentioned, if maintained the "skill-base" of the NPI positions it well against future opportunities across its wide brief of activities.

The collective vitality of the NPI is hard to gauge given its size and the scope of its activities which include more than just scientific research per se. There was no sense in the discussions with the panel during the visit to the NPI of any lack of vitality.

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 well-being of the Institute beyond issues which arise and are documented both above and in respect of individual research teams below.

B. Evaluation of the individual teams

Evaluation of the Team No. 1: Theoretical Physics

1. Introduction

The Department of Theoretical Physics with a scientific staff of around 20 scientists covers a very wide field of nuclear and particle physics subjects. The covered areas include hadron-hadron interactions, strangeness production, structure of nuclei and hypernuclei, weak and electromagnetic interactions, QCD, quantum theory on graphs and waveguides, Schroediger operators and spectral geometry, and quantum theory using non-hermitian operators of observables. The scientific output is impressive and highly quoted, showing a truly international quality. International connectivity is also documented by the involvement in international consortia and projects, including the SPHERE collaboration and the groups around LNS, LHC, Jefferson Laboratory, and the ALICE and PANDA collaborations.

2. Strengths and Opportunities

The Department of Theoretical Physics is well known in the international community as documented by several prestigious conference series, workshops and schools organized by this group, and attracting scientists from all over the world. The personal structure of the team is very stable over the years. The age structure of the team shows a good fraction of younger scientists. The history shows success of former students to find positions in other institutes internationally.

3. Weaknesses and Threats

The output of the team and the involvement in international activities underlines the important role in the theory community. The width of the scientific spectrum might be hard to maintain despite the strong and high quality manpower.

4. Recommendations

The personal structure clearly demonstrates the ability to attract students and younger scientists. It will be important to provide positions to younger and returning members of the team to maintain the stable situation in the future.

5. Detailed evaluations

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

The scientific output is impressive and highly quoted, showing a truly international quality. The strong role in supporting leading international research is clearly visible. Impressive are also important results towards the understanding of the Λ-hypernuclear production rates, and the role of two-phonon states in determining the fine structure of the giant dipole resonance. Pioneering research into quantum graphs and waveguides should also be mentioned. The role of the members of the institute is well visible even in the many-author papers from the collaborations. Genuine internal research is demonstrated in international high-quality publications.

Declaration on the involvement of students in research

A specific strength can be seen in the involvement of students in the research. This is documented not only by the number of students defending there thesis and in a number of publications resulting from thesis work, but also in the history of several former graduate students being now in visible positions abroad, or returning from there.

Declaration on societal relevance

Besides the tuition for master- and PhD students, members of the team are actively teaching at the surrounding universities. Impressive is also the long list of involvements as members or even chairperson of national and international research committees, including the European Research Council. An important outreach –national and international- is also given by the organisation of a large number of conferences and summer schools.

Declaration on the position in the international and national context

The continuous effort to stay at the forefront of national and international activities in the field of theoretical nuclear physics proves fruitful as documented by the leading role in the organisation of international conferences and workshops embedded into international consortia. This effort is not slackening but rather publications show engagement in additional communities (PANDA) and research areas.

Declaration on the vitality and sustainability

The number of students is matching the active role of the members of the institute. The age structure therefore spans from young students over post-doc levels to very senior, but still active scientists. The group has proven to refresh both the subjects of research activities and the scope of the group members. Obviously this process is running in a rather well organized way, without restricting individual vitality. With this background it is foreseeable that this department will maintain an active and leading role also in the future. Within the ongoing cooperations a solid structure is given, but the way to more explorative work is also open.

Declaration on the strategy and plans for the future

The plan for the future involves in particular the projection to maintain a highly visible position by organizing internationally attractive conferences and workshops. This itself provide a strong motivation for researchers to be part of this group, and to develop interactions with experimental and theoretical groups within the institute, nationally and internationally. It will also lead to a continuous adjustment and possibly also change of the wide range of scientific projects.

Evaluation of the Team No. 2: Ultrarelativistic Heavy Ions

1. Introduction

The Ultra-relativistic Heavy Ion group at the Institute is respected world-wide for its contributions to what is the “cutting edge” of research in the physics of hadronic matter, that is, matter which is presently classed as “visible” rather than “dark”, in our understanding of the Universe an also the fundamental structure of matter in it. The research achievements of the group, both with the STAR experiment at the RHIC heavy ion collider and with the ALICE experiment at the LHC when running with lead ions, are recognised internationally for their scientific importance in the context of achieving an understanding of phase equilibria in chromodynamics (QCD). Understanding hadronic matter in the Universe is not only pivotal in nuclear and sub-nuclear physics, but also it is the only “laboratory” at which it is possible to probe phase-equilibria in a non-abelian quantum field theory.

2. Strengths and Opportunities

The strengths of the group are that it has a central role in critical aspects of the functioning of both the STAR and ALICE projects as data-taking experiments which continue to enable it to play central roles in both. This is exemplified by its reported roles and its leadership responsibilities at CERN and at BNL which are substantial for a group of its size. Its physics publications are at the focus of the questions which must be addressed and answered if we are to extract as much as possible of the phase diagram of hot hadronic matter, in particular in relation to quark flavour production (that is, quarkonia production). The involvement of the group in both STAR and ALICE is noteworthy in respect of the different kinematic domains (both energy/temperature and ions/chemical potential) that it enables, something which is very important when trying to map phase equilibria. The new commitment to the upgrade of the ALICE experiment at CERN in the form of the new silicon track detector (ITS) with other collaborating institutes world-wide is well-thought through in respect of the size of the group and the contributions which it can, and will, make. It also is exactly what is needed in the next stage of what has been its successful set of measurements (2010-2014) of quark flavour production which has been led by members of the group in the wider ALICE collaboration.

3. Weaknesses and Threats

There are no manifest weaknesses in the group and in its outputs during the evaluation period. The threat to continuing success is a reduction in staff levels, something which would jeopardise not just the work of the group but also the work of the international collaborations STAR and ALICE of which the group is part. Given the plans for RHIC and LHC-ion data-taking and the expected return in new physics which the manifest success of the group would bring in on-going data-taking at both colliders, it is therefore of paramount importance for the excellence of Czech physics in an international context that full support continue to be given to the group.

4. Recommendations

The high energy heavy-ion physics programme at the Institute brings to the Institute a physics program which will for the foreseeable future continue to position it at the forefront of one of the biggest questions in contemporary physics, namely the quest for an understanding of the dynamics of hadronic matter in the Universe. Such a question ranks as one of the most important in contemporary science, both for physics in terms of the mechanisms underlying its dynamics and their place in the search for a grander unification of QCD with the electroweak sector of the Standard Model and for astrophysics and cosmology in terms of the role of visible matter in both. The group is positioned centrally in

the international experimental programs on which progress will depend for the foreseeable future, and this excellent state of affairs should not be jeopardised in any way. Therefore the group should be supported as strongly as possible.

5. Detailed evaluations

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

The group plays a disproportionately large and pivotal role in the STAR and LHC-ion physics programs. It has led the physics publications which it quoted in this review. Furthermore, its contributions to all ALICE and STAR physics publications are also significant because of the central roles of the group in the operation, on-going calibration and monitoring of crucial aspects of both experiments, and its contributions to data-processing.

Declaration on the involvement of students in research

PhD students in this group work in an international environment with their peers and with scientists of international distinction. Their education, and their research achievements, should be seen in this context. The numbers of students in the group is appropriate.

Declaration on societal relevance

The physics program addresses questions which can be, and are by the group, presented to the general public in exciting and stimulating ways. The technologies which drive the experimentation present many opportunities to involve industrial involvement, have made an impact in this respect in this reporting period, and can be expected to do so to a greater extent throughout the period of the Czech contribution to the semi-conductor track detector (ITS) in its construction.

Declaration on the position in the international and national context

The group is embedded in high-priority science programs in two continents, North America and Europe, in which also collaborators from a third are also involved!

Declaration on the vitality and sustainability

The group’s position of international distinction should not be jeopardised by reductions in staffing both scientifically at all levels and technically.

Declaration on the strategy and plans for the future

The future of the group in the present evaluation period (2015-2019) is well planned and clear. Beyond this period excellent science will continue unless there is a conscious decision in the Czech Republic not to continue to pursue it, which right now if it were to happen would lead to a substantial loss of good science.

Evaluation of the Team No. 3: Relativistic Heavy Ions, Neutrino Properties

1. Introduction

The team consists of three groups which participate in different international nuclear physics projects:

- HADES experiment which is a dedicated facility for detection of nucleus – nucleus interactions at medium energies which makes possible to study variety of nuclear phenomena. The HADES spectrometer was build and operated with a significant contribution of the Czech Republic and it is presently installed at GSI Darmstadt. The Czech group participated during the evaluation period also in the analysis and interpretation of measured data. The team scientists have been involved in the upgrade of the HADES and the preparation of the HADES successor CBM experiment which will be installed at the accelerator complex FAIR constructed at Darmstadt.
- KATRIN experiment, the goal of which is to determined or set limits on electron neutrino mass using tritium decays. This physical topics belongs at present to the most principal subject of elementary particle physics. The KATRIN experiment is in the construction phase and the Czech group concentrates on the calibration of KATRIN energy scale for the determination of the tritium spectrum end point. For this aim the Czech group developed and successfully tested an original high voltage monitoring system for the electron main spectrometer.
- Accelerator driven transmutation technologies as a possible source of neutrons for transmutation of nuclear waste or production of nuclear fuel from thorium. The experimental setup was assembled at JINR Dubna and spallation target was irradiated by relativistic protons and deuterons. For the detection of neutron flux the group members developed activation detectors from various materials and measured activation neutron cross sections in these materials at the neutron source at Řež and Uppsala cyclotron. The resulting data are included in the EXFOR database and means an important step for the detection of spallation neutrons.

2. Strengths and Opportunities

Strengths:

- Current team research program is carried out in large international collaborations.
- Team members have long-term experience of the detector hardware which is indispensable for the operation of detectors of the above mentioned experiments. The HADES group played an essential role in the operation of large scintillating detectors TOF and Forward
- Hodoscope. Members of the HADES group have participated in data analysis and have good knowledge of data processing package.
- The KATRIN group developed a technology for producing a monitoring source which will be used in the monitoring spectrometer and which will make possible to determined electron energies with an unprecedented precision. The group role is substantial for the KATRIN project and the future running of the experiment.
- The team can profit from the large technical equipment of NPI e.g. NPI cyclotron U-120M.

Opportunities:

The new commitment of the team in the upgrade of HADES experiment and its foreseen installation at FAIR. Finishing of the installation of the KATRIN complex in 2016 and beginning of data taking in 2017. Participating of data taking at the spallation system in JINR Dubna and measuring of (n,xn) reactions at Řež and Uppsala in the framework of CHANDA European project.

3. Weaknesses and Threats

- Possible delay of the construction of the accelerator complex FAIR.
- Only 1 PhD defended in the evaluation period.
- Unbalanced age structure of the KATRIN group, i.e. not sufficient number of PhD students and postdocs in the KATRIN group, which might cause a serious problem when fulfilling the Czech duties in running KATRIN detector.

4. Recommendations

Due to the team commitment in the experiment HADES and KATRIN it is recommended to support the team research within NPI. The role of the team is important and weakening the team from any reason would cause difficulties for the whole collaborations. From this point of view the number of members of the Czech KATRIN group should be increased. The commission recommends to add scientific positions for this group by rearranging scientific teams in NPI.

5. Detailed evaluations

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

The team members contributed in general to HADES publications, which belong to the category of large collaboration outputs, because of the central role of the team in the operation and monitoring of two important detectors and the team role in the data taking.

They contributed also to the data analysis, since several papers are based on the results obtained by Czech PhD students, e. g. In-medium effects on K-0 mesons in relativistic heavy-ion collisions, Dielectron production in Ar plus KCl collisions at 1.76A GeV, Hyperon production in Ar plus KCl collisions at 1.76A GeV, Deep sub-threshold K*(892)(0) production in collisions of Ar + KCl at 1.76A GeV. The KATRIN papers are devoted to results obtained by developing of various types of radioactive sources Rb-Kr and by measuring their spectra which will be used for the electron calibration of the KATRIN spectrometer. Here the team members are the only or main authors of the evaluated papers. Similarly, the Czech authors have major share in the evaluated publications dealing with the spallation neutron production.

Declaration on the involvement of students in research

Eight PhD students took part either in the detector development or in the data analysis, one PhD thesis was defended in the evaluated period. The most students are involved in the Accelerator driven transmutation technologies group participating in experiments carried out in Dubna or in the home institute, the number of HADES PhD students is appropriate. The KATRIN group has one PhD students only, who contributed significantly to the development and testing of Rb-Kr source in NPI, KIT and Bonn.

Declaration on societal relevance

Social relevance consists in the popularization and educational activities. Two team members presented the physics problems which are subject of their research to the general public in the framework of the outreach lectures on nuclear physics and neutrinos.

One team member gives regular lectures to various level students at the Faculty of Nuclear Sciences and Physical Engineering.

Declaration on the position in the international and national context

The team position in the international and national context is well established. The team experience and its quality have been recognized electing a team member as a technical coordinator of the HADES electromagnetic calorimeter ECAL. Another team member was during the evaluation period chair of the HADES collaboration board which represents about 25 institutes from Europe mostly. Similarly, the team is well recognized within the KATRIN experiment which includes about 15 Institutes from Europe and US.

Declaration on the vitality and sustainability

The age structure of the team is slightly unbalanced due to the age gap between 40 and 50. In view of the future team commitment in the HADES and KATRIN experiments it would be desirable to attract more PhD students and especially to attract them after the thesis defences to continue as postdocs. The team research program was supported from various funds which have been finished or have started in the evaluation period. The future financing is well ensured in the near future by the grant allocated to the KATRIN project (end 2016), HADES project (end 2017) and within the cooperation with JINR Dubna (end 2016). With respect to the long-term prospect of the three projects a continuation of funding beyond 2016 and 2017 is desirable.

Declaration on the strategy and plans for the future

The future of the team is well planned and well specified within all three projects. The expected results should bring new information about the nucleus-nucleus interactions at mediate energies, about the production of spallation neutrons and set a limit on the electron neutrino mass which is eagerly expected by elementary particle physics community.

Evaluation of the Team No. 5: Nuclear Reactions

1. Introduction

The team research is orientated to nuclear astrophysics, nuclei far from the stability, reactions near the Coulomb barrier and to the Fusion application. For this purpose the NPI cyclotron U-120M is employed along with facilities at foreign laboratories. The team participated in the determination of cross sections of several reactions which are supposed to play important role for big-bang nucleosynthesis elements and for the explanation of the observed abundance of some isotopes in space. To obtained cross sections at stellar energies the team applied NC and THM methods. The team members took part in the study of 34Si and 44S nuclei which are far from the stability in collaboration with GANIL laboratory. They investigated nuclear transfer mechanisms in the Coulomb energy region with 6He and 3H ions and different isotopic targets. The NPI cyclotron was used as a neutron generator for obtaining nuclear data which were included in neutron data libraries. The team members were involved in determination of neutron activation cross sections of materials used in fusion technologies. Similarly the team used NPI neutron high flux to test radiation hardness of microelectronics of the experiment ATLAS.

2. Strengths and Opportunities

The team can employ NPI cyclotron and perform experiments at energy ranges which cover the gap of the energy domain accessible at other world installations. The team members contributed significantly to the research important for astrophysics and to the application which are relevant for the fusion technologies. The planned installation of high power neutron generator at NPI is an opportunity for the team to strengthen its position in the internationally collaborations.

3. Weaknesses and Threats

The team has the age structure which could limit team activity and fulfilling its plans in future. No PhD thesis was defended in the evaluation period which represents significant weakness for future perspective of the team.

4. Recommendations

With respect to the team age composition and number of team members It would be advisable to continue the research on smaller number of topics to increase the team performance in the perspective team activity i.e. in the astrophysics and in the applied domain for fusion technologies, e.g. activation experiments. The team should increase activities in popularization of the research program to attract young people.

5. Detailed evaluations

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

The 14 publications evaluated within Phase I are mostly internationally excellent or recognized internationally. More than half of the evaluated results were obtained in the experiments performed in NPI and were published in papers where the team members are the only authors or have the main share in the acquisition of results In several evaluated outputs which deals with results obtained in experiments performed in foreign laboratories there are 1 to 5 team authors between about 20 authors. Here the team members contributed to the experimental equipment settings, simulations, data analysis and to the data interpretation.

Declaration on the involvement of students in research

The involvement of students in research was limited during the evaluation period. One master thesis and 2 bachelor theses were defended, no PhD thesis was defended. One PhD student took part in the team activity.

Declaration on societal relevance

The social relevance is at medium level. One team member participates in the pedagogical activities at the Faculty of Nuclear Sciences and Physical Engineering. The team members gave two lectures in the area of research popularization.

Declaration on the position in the international and national context

The team has several bilateral collaboration with foreign institutions e.g. with GANIL, France and IFNF, Italy. It has good position within the nuclear astrophysics community. The team is member of the collaboration board of NFS/SPIRAL2, Ganil and member of Consortium for Nuclear Data.

Declaration on the vitality and sustainability

The team is capable to use effectively the facilities of the Nuclear Physics Institute at the competitive international level. The team age structure is reasonable between 25 and 50. For the next 5 year period the team will face the leave of several senior scientists which could cause difficulties of realisation of team future plans.

Declaration on the strategy and plans for the future

The team intends to continue the research in the domain of nuclear astrophysics in collaboration with INFN by employing U12OM cyclotron and using Van de Graaff accelerator of IEAP CTU. The team will continue to obtain nuclear data for research and technology by improving experimental facilities at the cyclotron U120M and by installing them at the new NPI cyclotron TR-24. The research plans and upgrades of the experimental equipment is well planned, but without increasing of manpower these plans will be hard to reach.

Evaluation of the Team No. 6: Research with Ion and Neutron Beams

1. Introduction

The main activity of this team of 7 researchers is in the application of ion beams and neutrons for material science, using the accelerator at the Tandetron Laboratory and the LVR nuclear reactor.

Tandetron Laboratory is a unique lab in the Czech Republic dealing with a broad field of ion beam analytical methods. Cooperations with highly visible centres on the top of European research are established to share research topics and instrumentation.

At the LVR-15 nuclear reactor devices for Neutron Depth Profiling (NDP) and Prompt Gamma Activation Analysis (PGAA) are using the external neutron beam. Present foci of research are : Nanostructures in crystalline materials for photonics and spintronics, Metal/polymer nano-composites and nano-structures, Energetic loss study in different materials, Graphene based structures characterized by ion beam analytical methods, Microbeam application on ion beam writing, and Neutron beam applications including NDP application is depth profiling of boron, lithium and nitrogen in various materials, and PGAA application for non-destructive determination of elemental composition of different materials. Besides the research utilizing nuclear analytical methods, the group deals also with novel materials with a high application potential, such as materials for biosensors, gas sensors, tissue engineering, and hybrid (metal-organic) thin films.

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2. Strengths and Opportunities

The team has a broad experience in the application of medium energy ion beams from the Tandetron laboratory and the LVR-15 nuclear reactor, and can use these resources for a well-established research. The Tandetron accelerator and ion beam analytical instrumentations is upgraded continuously and their parameters are at European level. Significant improvements were realized recently in the frame of CANAM (Centrum of Accelerators and Nuclear Analytical Methods). New ideas including e.g. the ion beam analysis of archaeological artefacts in cooperation with the University of Messina, Italy, are started to enlarge the field in the upcoming years.

3. Weaknesses and Threats

There is a certain limitation given by the limited energy range of the accelerator, but the group has successfully selected an interesting field of applications, well competitive on European level.

4. Recommendations

The team needs a balance of researchers and technical personnel. This has to be observed in the following years.

5. Detailed evaluations

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

The research of the team is concentrated in a more technical direction. A majority of publications is therefore in journals like NIM, and therefore not on a very high scale of impact. Nevertheless these results show a high standard in the international comparison. The few members of the team are important co- or leading authors. Some publications seem to emerge from research of other teams at the facilities of the institute, which has to be seen as a good achievement, too.

Declaration on the involvement of students in research

Given the small number of researchers, contributions by graduate students (overall 5) and other students is significant.

Declaration on societal relevance

The members of the team are actively engaged in lecturing and tutoring at different universities. Group members are also active in advisory boards within the Czech Republic and the EU and actively participating in outreach activities.

Declaration on the position in the international and national context

The Tandetron Laboratory is a unique lab in the Czech Republic and well visible on the European scale. Cooperations within the EU and with other partners demonstrate the international visibility of the research. The new CANAM center and new projects together with national and international partners are manifesting this positon.

Declaration on the vitality and sustainability

The group has established a well rounded field of activities which it is constantly adjusting. The group structure shows a reasonable age structure and a balance of researchers and technical members.

Declaration on the strategy and plans for the future

The plans for the next years show a strong strategy aiming for a further growth of national and international collaborations. The continuous improvement of the research facility, as demonstrated over the last period, seems to be warranted for the future.

Evaluation of the Team No. 7: Neutron Diffraction

1. Introduction

The team research is concentrated on experimental neutron diffraction employing neutron beams accessible at the research reactor LVR-15 in Řež. The neutron diffraction has in some cases better resolution than other diffractive methods (e.g. X ray method) and it has a long-term tradition in NPI. The team members provide the experimental infrastructure and the choice of neutron diffraction methods for external users from the Czech Republic and from abroad. They further pursue material research, develop more efficient neutron scattering methods and upgrade the corresponding infrastructure in NPI. The material research is oriented on the study of materials under thermo-mechanical loading, microstructure of novel materials and crystallography. The team improved the Bragg diffraction optics and applies it in a dedicated instruments constructed in Korea and in the development of new types of crystal monochromators. The team is deeply involved in the project European Spallation Source constructed in Sweden which became the key project of the team.

2. Strengths and Opportunities

Strength:

- Availability of neutron beams at the reactor LVR15 in Řež.
- Employing of Institute diffractometers i.e. high resolution TKSN-400, double crystal small-angle scattering MAUD and MEREDIT.
- Developing a simulation software which has been used in Institutes abroad.
- Extended expertize for the interpretation of diffractograms.

Opportunities:

- Participation in the dedicated instruments in KAERI Daejeon, Korea.
- Strong participation in the construction of European Spallation Source in Sweden i.e. a neutron beam line and a diffractometer for European material Engineering Research.

3. Weaknesses and Threats

During the evaluation period the team did not have PhD students until 2014, when 2 PhD theses have started. Otherwise there are no weaknesses in the group. Threats could arise in case of insufficient fund support of the team.

4. Recommendations

Due to the team commitment to the project ESS it is recommended to support the team research within NPI. The role of the team is important and weakening the team from any reason would cause difficulties for the whole ESS collaboration. The Commission recommends to continue the planned upgrade of the neutron instrumentation at the reactor LVT15, since it will bring the improvement of neutron diffraction experiments. The material research should continue, since it has important impact on applied physics. It is essential to increase activities in popularization of the research program to attract young people. In view of the sustainability of the team and the Czech involvement in ESS more PhD students should be involved in the team activity.

5. Detailed evaluations

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

The results are important for applied physics, e.g. crystallography, material science, solid state chemistry. Some of them dealing with development of improved diffraction methods have been obtained at the neutron beam line in Řež and published in papers where the team members are the only authors or have the main share in the acquisition of results.

In other publication where there are one or two team members between other authors the part of results concerning neutron diffraction were reached also at the neutron beam line in Řež. Here the team members were responsible for the experimental equipment and the interpretation of diffraction data. The evaluated publications have mostly quality which is internationally excellent or recognized internationally.

Declaration on the involvement of students in research

During the evaluation period no PhD thesis was defended. Involvement of students in the research was limited since 2 PhD theses have joined the team by the end of 2014.

Declaration on societal relevance

Social relevance lies in providing experimental infrastructure to academic and industrial research community.

Declaration on the position in the international and national context

The team is involved in several smaller international collaboration e.g. with the University of Uppsala and with a Korean reactor group in KAERI. During the evaluation period the team credit has been growing within the neutron scattering community. The importance of team position in the international collaborations is underlined by the team deep participation in the large international research infrastructure European Spallation Source which includes about 18 institutes from Europe. The NPI belongs to the founding Institute of this project and the team proposed a concept for a diffractometer for ESS. The team is with the German partners from the Helmholz Zentrum Geesthacht responsible for the construction of the beamline for European material engineering research in ESS.

Declaration on the vitality and sustainability

The team age structure is uniformly distributed between 30 and 70. It would be desirable to increase number of team members at the postdoc and technical positions. The team research program was supported from various funds which have been finished or have started in the evaluation period e.g. European grant FP7 NMI3-II (end 2016), Czech grant allocated to ESS (end 2015). The funding was adequate with comparison of the research output.

Declaration on the strategy and plans for the future

The future of the team is well planned and well specified. The team expects new results in material research and in the construction of the neutron scattering instrumentation for ESS. Similarly it plans an upgrade of the instrumentation for neutron diffraction in Řež. The funding of team projects beyond 2016 is not specified in the NPI report.

Evaluation of the Team No. 8: Dosimetry of Ionizing Radiation

1. Introduction

The research topics are concentrated to three areas:

- Dosimetry of complex radiation fields. The passive detectors developed by the team members have been placed on board of the ISS and aircrafts. Measured doses are compared with computer codes which are tuned to obtain agreement with experimental data. The team is engaged in the measurement of quality of therapeutic ion beams for cancer therapy.
- Radiation biophysics and biology. The biological consequences of radiation of DNA have been studied using carbon and iron beams of several hundred MeV/n available at Sweden. DNA damage has been further investigated by means of soft X rays, protons an low energy ions. The team performed also radiobiological experiments in clinical proton beam at the Proton Therapy Centre in Prague. The team continued to develop theoretical modelling of biological effects included in team software package RADAMOL and within the Geant4 simulation.
- Environmental dosimetry. The team has used the radiocarbon dating methods for the age determination of various samples of archaeology, geology, botany, etc. The team developed new methods for the determination of 14C by means of Accelerator Mass Spectroscopy measurement, which needs much smaller amount of carbon with respect to the conventional approach. The team members are involved in the precise determination of 14C in atmosphere in general and especially in surroundings of nuclear power plants Temelín and Dukovany. The team performed a search of possible enhanced activities of other radionuclides, e.g. tritium and strontium.

2. Strengths and Opportunities

Strength:

- Long-term experience in the dose measurement on board aircrafts with the silicon spectrometer Liulin.
- Unique expertise in the methodology of linear energy transfer spectrometry by track-etched detectors and in the determination of out-of-filed doses during radiotherapy using various passive detectors.
- Successful study of DNA damage caused by various types of radiation and long-term development of theoretical modelling of biological effects of ionizing radiation.
- Long-term experience in the carbon dating methods and the determination of 14C in atmosphere.
- Co-operation with other scientific branches, e.g. archaeology, geology, chemistry.

Opportunities:

- Experimental international cooperation on the dosimetry on board of ISIS
- Collaboration with the German Cancer Research Centre in Heidelberg on application of combinations of solid state track-etched and fluorescent nuclear detectors for passive dosimetry.
- Collaboration on the determination of cellular response to low dose radiation with the underground laboratories LSM (France) and LNGS (Italy).

- Installation of an accelerator mass spectrometer in NPI In cooperation with other Czech research groups.

3. Weaknesses and Threats

There are no particular weaknesses and threats.

4. Recommendations

No special recommendations are needed. The research should continue in the directions listed in the introduction. The support of the team by the NPI is recommended to continue both by institutional funding and by assuring research positions for the team.

5. Detailed evaluations

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

The team is successful and achieved interesting results. The quality of evaluated outputs belongs mostly to the category of outputs recognized internationally or nationally. In most of publications the team members are the only authors or have the main share in the acquisition of results. The results obtained by applying radiocarbon dating methods for archaeologic samples are important at the national level. Similar importance has the determination of 14C activity in the atmosphere in the surroundings of the Czech nuclear power plants. The dose determination in ISS and aircrafts has worldwide impact on the radiation protection of crews.

Declaration on the involvement of students in research

During the evaluation period team members supervised 12 bachelor works, 10 diploma works and 11 PhD thesis. All students participated in the research activities of the team and they were involved in various Czech grant research programs, in experiments performed in the framework of EURODOS research projects and in collaborative projects with JINR, Dubna. Five PhD thesis were defended between 2010 and 2014.

Declaration on societal relevance

The team members have taught in master and doctoral programs of the Faculty of Nuclear Sciences and Physical Engineering. Their nine semester courses have been devoted to radiation dosimetry and radiology physics. Team has also extended popularization activities for general public, for secondary school students and for university students from other branches. Team research has direct impact on the radiation protection of aircrews, on the age determination of archaeology, botany, geology samples and on a possible enhancement of radioactivity around nuclear power plants. The companies ETE, EDU, Cambera-Packard and Envitel expressed their interest in the method developed by the team for the dose measurement of 90SR and 89Sr by liquid scintillators.

Declaration on the position in the international and national context

The team collaborates with several Czech Institutes of CAS, e.g. Institute of Physics Institute of Archaeology CAS, Institute of Botany, Institute of Geology. The team position within international dosimetry community is well established. The team has several bilateral collaborations with foreign institutes, e.g. the Calmers University of Technology, Sweden, with the University of Paul Sabatier in Toulouse, University of Bordeaux, with the Germen Cancer Research Centre in Heidelberg, with JINR Dubna and with National Institute of Radiological Sciences, Japan. The team researches actively contributed to EURODOS work group WG6, WG9 and WG11.

Declaration on the vitality and sustainability

The team age structure is well balanced. The research programme is attractive for young people, since the team has sufficient number of PhD students who might continue as postdocs in NPI. The team funding during the evaluation period was adequate with respect to obtained results.

Declaration on the strategy and plans for the future

The future plans of the team are well specified. The team will continue in the research topics mentioned in the introduction. The team members plan to start a research of the cellular response to extremely low doses by exploiting deep underground laboratories LSM in France or LNGS in Italy. They intend with other Czech Institutes to install accelerator mass spectrometer in NPI. The funding beyond 2016 is not specified in the Institute report.

Evaluation of the Team No. 9: Radionuclides and Accelerators

1. Introduction

The team is nationally and internationally acknowledged for the production of radio-nuclides for scientific and medical applications and the measurement of excitation functions, making use of the U120 M cyclotron. Within the team the cyclotron facility is maintenanced and gradually improved to provide a reliable source for these purposes. Although the energy range and intensity is limited (protons to < 35 MeV) the team established efficient methods of production of novel tracer radio-isotopes. Besides the U 120 M cyclotron a modern compact cyclotron was purchased, and integrated into an existing accelerator building.

This provides higher beam current and can operate at reduced maintenance effort, well suited for the production of specific isotopes and experiments at low excitation cross-section. Together with the synchrotrons, the compact electron microtron MT25 is operated, and was developed into an attractive source for neutrons.

The combination of further source and target development and multi-disciplinary research in the direction of novel schemes for tracer materials has pushed the team into a leading position especially in the direction of radiopharmaceuticals, where a replacement of reactor produced material is of strong interest. Besides this highly merited role the accelerator facility is also used for other developments like the production of bright luminescence diamond nano-particles. For this research both proton beams and electron beams were used.

2. Strengths and Opportunities

The strength of the team is based on a seamless combination of technology oriented accelerator developments with scientific projects with a mixed community between physics, nuclear chemistry, biology, pharmacy and medicine. Obviously this makes the group attractive for students from the different disciplines.

National and international collaborations provide an environment where the adequateness of developments is well observed. With the continuous improvement of the facility and the established in the development of tracer substances, a strong role in this field will be guaranteed. In addition, within the limits of the accelerator machinery, the team has shown to be able to contribute to basic research.

3. Weaknesses and Threats

As any technology driven research, the team is depending on the continuation of the efforts to maintain a world-class machinery. For the nearest future this means- besides the accelerator developments- that the nuclear chemistry and pharmaceutical laboratories have to fulfil high reliability criteria.

4. Recommendations

The challenges of the next phases will require highest quality manpower in the scientific as well as the technical sector. The tendency of the last years shows a reduction rather than an increase of the total manpower. This situation should be used to further improve the quality by filling up gaps.

5. Detailed evaluations

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

The list of publications is impressive. Although in the detail publications in very high impact general Journals are missing, an internationally visible and acknowledged level can be attested. It is clearly demonstrated in particular, that the effort to not only demonstrate a complimentary method, but to provide a leading source for the production of radiopharmaceutical compounds is well on its way. The importance of the members of the group in the publications is distinctively marked for most publications. Many of the publications are authored together with other – national and international – partners. This demonstrates interlinking with other teams and institutes, which is a particular strength of this team.

Declaration on the involvement of students in research

The scientific part of the team is rather small. The number of students is integrally larger than this part of the team. This is documented by the positive thesis results.

Declaration on societal relevance

Societal relevance is inherently given by the fact that most of the research is directed towards important medical and biological thematic. Technical developments are also important in the direction of material science and energy technologies. Besides this important fact, the team is also active in pedagogical actions. Teaching activities are documenting the multi-disciplinary nature of the research. Another important outreach activity is given by the Open Access policy of the accelerators.

Declaration on the position in the international and national context

The team has connections with several international groups (TRIUMF, KIT, GSI, Mainz University, University of Würzburg) and a very active collaboration with institutes and universities within the Czech Republic. This is particular important to validate the competitiveness of the developments in the very active field of research in the pharmaceutical sector. The Open Access policy is attracting more partners. It is foreseeable that the improved facilities will add to this attractiveness.

Declaration on the vitality and sustainability

The group has proven to make a very good use of the facilities of the Nuclear Physics Institute, competitive on an international level. It provides a very good mixture of scientific and technological output. The manpower level has generally a negative trend. This has to be pursued in the future.

Declaration on the strategy and plans for the future

The strategy is based on a balance among the different pillars, with a strong commitment to medical and biophysical developments and technical and methodological developments of the machinery. This seems to be a very reasonable use of the existing resources and can be expected to lead towards a successful future.

Date: January 13, 2016

Commission Chair: Prof. John Dainton