

# **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 Physiology of the CAS, v. v. i.

**Fields, in which the Institute registered its teams:**

Metrology and diagnostic methods

Observer representing the Academy Council of the CAS: Jiří Chýla

Observer representing the Institute: Ladislav Vyklický, substitute observer Jiří Pácha

**Commission No. 8: Engineering and technology**

Chair: em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel

Date(s) of the visit of the Institute: October 12 - October 21, 2015

Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:

*No. 6 - Biomathematics*

## **EVALUATION OF THE INSTITUTE OF PHYSIOLOGY (IP)**

### **1. INTRODUCTION**

#### **1.1 Location of the institute and its dept., labs. & sub units.**

IP is located in Prague 4, Vídeňská 1083 including the majority of its subdivisions.

#### **1.2 Brief history of the institute**

The institute was established in 1954. In the initial phase the research topics referred to neurophysiology, heart adaption, muscle regeneration. Since the beginning of the 1990'ties it improved its relations to the international community, especially at EU level. Today's research activities are described in detail in 5.1 and 1.3, just below.

#### **1.3 Mission and research topics**

The Institute's mission is to deepen and broaden the fundamental knowledge on physiological and pathological processes implicated in specific metabolic, cardiovascular and neuronal/brain functions to support novel prevention, diagnostics and therapeutic procedures. The main research tasks refer to neuroscience, cardiovascular physiology, metabolism.

#### **1.4 Staff size and full time equivalents age distribution**

Mean figures of IP staff yield about 407 employees and 88 PhD students. Expressed in FTEs 50 senior researchers 55 PhD-students, 20 Post Docs, 15 young scientists and 135 technical and administrative staff work at IP.

The age distribution is quite favourable indicating a peak between 25-30 years and then slowly decreasing. Surprisingly, about 44 people (about 10%) are above 65 years.

### **2. STRENGTHS AND OPPORTUNITIES**

Based on the findings of the detailed evaluation (see below topic 5) we should come up with some statements referring to:

#### **2.1 Timeliness of research topics**

The research topics are excellently adjusted to the international scientific research environment. IP has done a good job in concentrating on 3 well defined topics: see 1.3

#### **2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds**

The institutional budget covers about 50 % of total incomes. This is seen as a good ratio indicating the strength of IP to raise external funds. However, it should be considered that institutional support is decreasing and also the total budget, mostly due to a reduced income from national grants. A further decrease in institutional funds is considered as a critical development. The extended income from EU structural funds is appreciated.

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### **2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement**

There is a good collaboration among the teams within the institute that is also reflected by the number of joint publications. The collaboration with universities and other CAS units looks also quite satisfactory. At the national level major partners in collaborative work are Charles university, Masaryk university, and several institutes of CAS. 6 depts. participate at BIOCEV, (Biotechnology and Biomedicine Centre) funded by EU and jointly operated by CAS and Charles university.

IP is strongly involved in AV21 strategy with the emphasis on prevention and treatment of lifestyle related diseases. It includes 24 partners. 3 centres of excellence are coordinated by scientists at the institute.

Recently IP has launched a project of excellence in neuroscience to strengthen the cooperation of top scientists from different labs in Czech Republic. Main topics refer to neurodegenerative diseases such as Alzheimer, Parkinson, ALS.

IP is involved in 79 international projects including several FP 6 and FP7 projects.

### **2.4 The overall capacity of staff**

The mean staff capacity includes 407 employees and 88 PhDs (about 50-60 FTEs). In total 300 FTEs are reported from which 134 refer to technical and administrative staff and 160-170 to researchers. Senior researchers cover 65-70 FTE, Post Docs about 25-30.

The age distribution is quite favourable as it shows a peak between 25 and 30 years followed by a continuous decrease at higher ages.

### **2.5 Reasonability of the structure of the institute and the departments**

The institute has a complex organisational structure. It consists of 23 research depts., one applied research dept., six service depts. responsible for documentation and facility management, the BIOCEV division and the editorial board of the journal Phys. Rev, which cannot be considered as a dept.. The collaboration among the depts. is working well and several measures have been implemented to further strengthen it in mid-term.

### **2.6 Frequency and quality of publications**

In total 714 papers were published during the evaluation period with an increasing trend in number and in mean IF. The mean IF is about 3,4. 31 papers with an IF larger than 7 were published (3 in Nature, 3 in Nature Protocols, 3 Nucl. Acid Research,..).

Summing up the listed publications from then three main research topics (neurophysiology, cardiovascular research, metabolism) at total number of 778 papers would result. Considering that 160-170 FTE researchers are working at IP each researcher has published more than one IF paper in the average per year.

### **2.7 Patents and role in contractual work**

12 patents were obtained.

## **3. WEAKNESSES AND THREATS**

### **3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds**

The continuous decrease in institutional funding and national grant income is seen as a critical development path although it could be compensated by raising external funds at the EU level.

### **3.2 Staff capacity and age distribution**

Although the age distribution is quite favourable there are several team/group leaders who are already above 55 and even older. There are also about 10% of researchers in the age of above 65 years.

## **4. RECOMMENDATIONS**

The overall figures characterising the performance of the institute are excellent. Several measures have been implemented to improve collaboration among the teams, to enhance publication frequency and to increase research fund raising. Also the gender issue is recognised although the ratio of female researchers is much better compared to other institutes visited.

Due to the fact that only one from 23 depts. (dept. of biomathematics) has been evaluated during the onsite visit it is difficult to come up with recommendations.

### **4.1 Staff capacity and age distribution**

The age distribution is quite favourable but there are several team/group leaders who have to be replaced by qualified researchers in the near future. The institute has the capacity to solve this problem but measures should be taken soon to attract younger researchers, perhaps from abroad to stimulate the development of new research topics and to improve international scientific collaboration.

## **5. DETAILED EVALUATION**

### **5.1 Declaration on the quality of the results and share in their acquisition**

#### ***Characterisation of the main research activities (experiments, theoretical areas)***

The overall goal in research is in uncovering basic biological mechanisms to improve prevention, diagnostics and therapy of severe human diseases. Research centres around three major topics: neurophysiology, cardiovascular physiology and metabolism. A broad spectrum of methodological approaches is employed, covering molecular, cellular and systemic levels. A great majority of experiments is performed using animal and *in vitro* models.

Three centres of excellence with outside partners are coordinated by IP: neuroscience, cardiovascular research and the MITO-CENTRE. The latter started in 2014.

#### ***Relevance in the national and international context***

At the national level major partners in collaborative work are Charles university, Masaryk university, and several institutes of CAS. 6 depts. participate at BIOCEV, (Biotechnology and Biomedicine Centre) funded by EU and jointly operated by CAS and Charles university.

IP is strongly involved in AV21 strategy with the emphasis on prevention and treatment of lifestyle related diseases. It includes 24 partners.

3 centres of excellence are coordinated by scientists at the institute. Recently IP has launched a project of excellence in neuroscience to strengthen the cooperation of top scientists from different labs in Czech Republic. Main topics refer to neurodegenerative diseases such as Alzheimer, Parkinson, ALS.

IP is involved in 79 international projects including 10 FP 6 and FP7 projects, 4 Marie Curie and 5 COST projects. . It is involved in 20 international projects and it has signed 32 bilateral agreements (USA, UK, France, Germany, Spain, Russia, Poland, Slovakia, Israel, China, *etc.*)

### ***Overall quality of publications***

In total 714 papers were published during the evaluation period with an increasing trend in number and in mean IF. An average IF factor of 3.3 is reported. 31 papers with an IF larger than 7 were published (3 in Nature, 3 in Nature Protocols, 3 Nucl. Acid Research,...).

### ***Specification of the main achievements***

The research at different levels (molecular, cellular and systems level) provides the opportunity to transfer fundamental research into therapeutic measures.

In research of protein structures the emphasis is in studying regulation of selected proteins (1433 in particular) whose functions are controlled through protein-protein interactions.

Chemically modified bypass grafts were successfully tested suitable for the adhesion and growth of cells, particularly endothelial cells.

Neurophysiological research ranges from the cellular mechanisms of neurotransmitter release and actions of transmitters on their receptors to highly integrative functions of the central nervous system.

Several outcomes of this research constitute an improved scientific basis for the treatment of wide spread human diseases observed in highly civilized societies (high blood pressure, obesity, diabetes..)

## **5.2 Declaration on the involvement of students in research**

IP delivers numerous courses at 14 university faculties.

In the evaluation period 137 MSc and 163 PhD students were supervised by IP staff. So far, 120 MSc and 67 PhD defended successfully their thesis. Between 50-60 PhD (FTEs) worked at the institute together with about 15-20 Post Doc fellows. More than 50% of the PhD graduates work at Post Docs abroad (UK, Germany, Switzerland, Canada, USA, Italy, France, Spain). So far, 14 of them returned back to IP.

## **5.3 Declaration on societal relevance**

### ***Outputs providing information relevant for public policy decisions in all fields of life***

The institute executes research to improve the prevention, the diagnostics and the therapy of severe human diseases. The outcomes from 3 centres of excellence (neuroscience, cardiovascular research, mitochondrial biology and pathology) will have in the mid-term direct benefits for public health. Additionally, the close collaboration with laboratories and institutes outside of CAS will assist in transferring the research results quickly into improved diagnostics and therapy.

### ***Popularisation and similar activities***

Regular lectures are given by world renowned scientists to support dissemination of new research results within the institute.

To communicate the outputs of IP to a broader public several activities had been executed, including interactive video presentations, lectures to the general public as well a frequent reports in media (about 60-70/year).

### ***Ability to attract foreign researchers at different levels***

During the evaluation period 46 foreign visitors spent more than 1 month at IP.

## **5.4 Declaration on the vitality and sustainability**

### ***Composition of staff with respect to age and gender, qualification, international experience***

The mean staff capacity includes 407 employees and 88 PhDs (about 50-60 FTEs). In total 300 FTEs are reported from which 134 refer to technical and administrative staff and 160-170 to researchers. Senior researchers cover 65-70 FTE, Post Docs about 25.

### ***Funding (structure of the resources and its comparison with the outputs, grants and project activity***

Institutional funding shows a decreasing trend from 4,8 Mio € in 2010 to 4,0 Mio € in 2014. Also the project oriented funding (national research grants, EU funding etc.) shows a decreasing trend. To be more specific the EU funding from structural programs increased while the EU project oriented funding remained stable. The decrease in external funding is thus mainly caused by a decrease in national project funds. In 2010 about 92 % of the annual budget was covered by national grants while it was about 71 % in 2014, only.

A partial compensation of the falling trend in income has been achieved by increasing own economic activities. In total, the annual financial resources exhibit a falling trend of about 5 % since 2009.

### ***Organisational structure, recruitment methods, career system, incentives for females,***

A promotion program has been set up within the institute to motivate researchers in publishing activities and to attract funds. Approx. 10-15% of Institute's salary budget is provided for stimulation bonuses for researchers for their publication record and funds attracted by the department they belong to. These bonuses are distributed to individual staff members by departmental leaders.

## **5.5 Declaration on the strategy and plans for the future**

### ***Relevance of the out lined strategy and research plans***

The principal research goals of the recent evaluation period are kept for the future. The focus will be on mechanisms behind life style related diseases.

In its strategy IP clearly puts the emphasis in recruiting more PhDs and subsequently on attracting the best of them later as Post Docs. To support these plans the teaching activities, especially at Charles university, will be intensified.

It was also mentioned that the re-allocation of the institutional budget among the depts. will be considered as a strategic measure. Due to the fact that our evaluation team has only visited one of the many depts. it is impossible to come up with any recommendation in this respect.

## **EVALUATION OF THE INSTITUTE OF PHYSIOLOGY**

### ***Dept. of Biomathematics***

#### **1. INTRODUCTION**

##### **1.1 Location of the institute and its dept., labs. & sub units.**

The dept. is located at the same place as the institute: Vídeňská 1083, Prague 4.

##### **1.2 Mission and research topics**

The research activities are concentrated on following topics:

- In methodology the emphasis is on 3D image analysis, spatial statistics and object reconstruction
- The main technical tools are advanced microscopic techniques including Leica confocal microscopes, confocal and two-photon excitation microscopy, fluorescence and transmitted light microscopy

These techniques were applied in a wide range of projects, referring to capillary systems of the human placenta, rat muscles and brain; conduction system of the heart; extracellular matrix proteins; structure of the nucleus and of the endoplasmic reticulum; architecture of the spruce needle and its cells; bird brain anatomy.

##### **1.3 Staff size and full time equivalents age distribution**

8 researchers, from which 3 are females, work at the dept., supported by 8 technical and administrative staff. This corresponds to 5-6 FTEs in research and a decreasing number of FTEs in technical and administrative people. In 2014 only 2,3 FTE are reported.

The age structure of the team is unfavourable. All the listed researchers are above 40 and two above 65. There is a clear gap in younger researchers.

#### **2. STRENGTHS AND OPPORTUNITIES**

##### **2.1 Timeliness of research topics**

The research topics are well chosen and also appropriate in the future. Fundamental research is done with a high potential for application in medical diagnostics and therapy in the mid term.



## **2.2 Intensity of collaboration among teams and among institutes, national collaboration and international involvement**

The collaboration of the dept. with other teams of the institute is satisfying, also with other CAS institutes. Further links with Charles University, IKEM, and companies exist. At the international level joint research activities with University of Ljubljana (Slovenia) and Loma Linda University in California, USA are listed.

## **2.3 Position of the institute within the Czech scientific community and its international position**

The dept. is well embedded at the national level and is involved in two international collaborations.

## **2.4 Frequency and quality of publications**

49 IF papers have been published by 5-6 FTE researchers. This results in at least 2 IP papers per year and full time researcher. The quality of the papers is excellent and 10 from the 11 papers, reviewed in Phase I, were in the top quartile of AIS journals.

# **3. WEAKNESSES AND THREATS**

## **3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds**

No data were about budgeting were provided at the dept. level. All the financial data referred to the level of the institute.

In the description of activities several financing institutions are listed besides the institutional sources. Funding comes from Czech Science Foundation and Czech ministries. No reference was given with respect to EU projects. The international collaboration with University of Ljubljana is based on travel grants.

So, the external funding needs substantial improvement. This would also help in hiring more, especially younger researchers.

## **3.2 Intensity of collaboration among teams and among institutes, national collaboration and international involvement**

International collaboration is limited to two institutions. In one case the collaboration is based exclusively on travel grants and this is very probably the explanation that no foreign researchers work at the institute, except of short term visits.

## **3.3 The overall capacity of staff**

The staff size is not big but concentrating on a few “hot topics” is an option to yield an excellent publication record.

The age structure is unfavourable as all 8 researchers (5 -6 FTEs) are above 40. No PhD student is at the moment at the dept. and only one has been supervised and defended his thesis in the last 4 years.

#### **4. RECOMMENDATIONS**

##### **4.1 Internal programs to stimulate actions to enforce strengths and to reduce weaknesses**

A scheme should be elaborated at the level of the institute to stimulate attraction of grants and publications.

At the dept. probably the external funding should be improved at both national and international level. The good scientific status of the dept., underlined by the frequency and quality of publications, should be used to improve collaboration within EU and to receive more EU grants. An increase in the external budget would facilitate employment of younger researchers.

##### **4.2 The overall capacity of staff**

The whole research team lacks young researchers. Both, PhD students should be attracted and some of them should be further employed. Plans going in this direction exist but measures should be taken soon.

An increase of the international collaboration is seen also as a sound basis to attract foreign researchers, at least to extend the duration of their visits.

##### **4.3 Name of the department**

The dept. name “Biomathematics” is somewhat misleading as the dept. has a strong component on technology, such as advanced microscopy and specimen handling and treatment.

Perhaps renaming the dept. would be appropriate to display the excellent research results in a better way to the outside community.

#### **5. DETAILED EVALUATION**

##### **5.1 Declaration on the quality of the results and share in their acquisition**

###### ***Overall quality of publications***

The team published in total 63 papers from which 49 are articles in IF journals, 4 in other journals, 8 contributions to proceedings and 2 book chapters.

From the 63 publications 11 were evaluated in Phase I. 2 publications were considered as world leading contributions and 6 as internationally excellent. The papers were published in high quality journals as can be concluded that 10 from the 11 reviewed papers were in the top quartile of AIS journals.

In general, it can be concluded that the quality of papers refers to the categories world leading and internationally excellent. The recognition of the papers in the international community is underlined by the good number of citations.

The focus of numerous papers (29) is on vascular diseases, physiology, material sciences (somewhat surprisingly), biomedical engineering, biology, microscopy, plant sciences, anatomy and morphology.

### ***Specification of the main achievements***

In several projects the capillary bed in various tissues has been studied involving visualization of the 3D architecture of the tissues by confocal microscopy. The description of the changes in capillary bed often required innovative methods for 3D image analysis.

The development of a muscle fibers classification and myosin composition in masseter muscle are among the main achievements of the evaluation period.

Several results were obtained with respect to detection, visualization and analysis of capillaries in brain, in skeleton muscles, in human placenta, etc. In these studies methods for measurement of capillary bed in 3D using automatic and interactive stereological methods were improved. Anisotropic effects were studied by novel concepts.

It included also development and testing of methods for preprocessing of microscopic images to remove errors and disturbing external effects (e.g. illumination). For the analysis of dynamic processes particle tracking tools have to be adjusted to study image sequences.

High resolution 3D images of cell growth were obtained by fluorescence techniques such as two-photon excitation microscopy. Such 3D image analysis techniques were also applied to plant anatomy studies to evaluate the effect of CO<sub>2</sub> increase on plants (beech and spruce).

Besides its research activities the dept. provides also quite relevant service functions in different advanced microscopic technologies, visualization and image processing.

## **5.2 Declaration on the involvement of students**

Staff members are involved to a limited extent in teaching activities at Charles University and Technical University Prague.

The involvement of students in research is quite limited. Two graduate students (one stayed only shortly at the dept.) contributed to research and publications, as well as one PhD-student. The latter graduated in 2014 and she wrote several papers. She was the only PhD student who was supervised and who completed also his studies in the period 2010-2014.

### **5.3 Declaration on societal relevance**

#### ***Outputs providing information relevant for public policy decisions in all fields of life***

The research activities are considered as fundamental studies with a high mid-to longterm potential in practical application in diagnostics and therapeutics (Alzheimer disease, cardiovascular diseases,...)

#### ***Popularisation and similar activities***

Popularisation is not in the focus of the dept. There was a contribution to the 18<sup>th</sup> Int. Microscopy Congress, held in Czech Republic, by organising a side popular event. Also some publications in a popular Slovak journal are mentioned.

### **5.4 Declaration on the position in the international and national context**

The department has close collaboration with other depts., such as the dept. of biomaterials and tissue engineering, dept. of cardiovascular morphogenesis, dept. of computational neuroscience and dept. of biochemistry of membrane receptors. Several joint activities were executed with other institutes from CAS (Laboratory of Biology of Cytoskeleton of Institute of Molecular Genetics, Laboratory of Biology of the Cell Nucleus of Institute of Molecular Genetics) and outside institution such as Charles University, IKEM, and companies.

International collaboration exists with University of Ljubljana (Slovenia) and Loma Linda University in California, USA:

Mostly Czech researchers work at the dept.. Only short term visits from international researchers are taking place. Independently from these facts, the scientific results of the team are excellent and internationally respected.

### **5.5 Declaration on the vitality and sustainability**

The dept. would be able to continue its recent researcher for the next period but there are two gaps which endanger its successful long term development. One refers to the lack of young researchers and the attraction of PhD students. The second refers to limited external funding, especially at the international level.

The high level technical equipment (advanced microscopic technology) needs to be repeatedly replaced after some years which puts some financial burden on the dept. and the institute.

### **5.6 Declaration on the strategy and plans for the future**

#### ***Relevance of the out lined strategy and research plans***

The outlined short term goals include a list of intended publications. Further, several projects with other depts. of the institute and with outside partners (e.g. Palacky university) are in preparation.

The long term goals over the whole period 2015-2019 include:

- Analysis of the morphology of cellular ultra-structures, of tissues, of capillary bed, of developing heart and of brain in phylogeny and ontogeny by advanced imaging and mathematical methods.
- 7TM receptor studies will be continued and if possible, extended from former rat brain studies to monkey rhesus macaques.
- Application of Raman spectroscopy in studying molecular structures implicated in Alzheimer diseases.
- Studies on light distribution within plant leaves by interference microscopy are planned.

Further, several international collaborations will be continued and new collaborative efforts will be initiated.

Some of the equipment will be replaced, optical methods will be improved and new equipment is planned for the coming period.

***Adequacy of available means and human resources to achieve these plans***

In general, no major changes in focus of research are planned for the next period. Most of the past activities will be continued or intensified. The defined goals are reasonable and it is very likely that they will be reached.

Two younger researchers, after having finished their PhD-studies, will work at the dept. after about 2 years. There is obviously a lack of PhDs at the dept. and the involvement of 2 new researchers is appreciated but not sufficient.

**Date:** January 20, 2016

**Commission Chair:** em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel