

**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 Hydrodynamics of the CAS, v. v. i.**

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

Materials engineering, materials science and nanotechnology

Observer representing the Academy Council of the CAS: Jiří Chýla

Observer representing the Institute: Petr Filip

**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. 1 - Hydrodynamical Aspects of Fluid Mechanics*

## **EVALUATION OF THE INSTITUTE OF HYDRODYNAMICS (IHD)**

### **1. INTRODUCTION**

The documents provided for the institute (IHD) and for the team of hydrodynamical aspects of fluid mechanics overlap to broad extent complicating a discriminative evaluation. This refers to the description of the research topics, funds and grants, publications, and future plans.

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

The institute (IHD) is located in Prague 6, Pod Patankou 30/5, and has two research depts. (dept. of mechanics of fluids and disperse systems, dept. of hydrology and the environment) and an administrative dept.). The depts. are subdivided into research groups or teams and laboratories. The subdivision is triggered by research grants.

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

The Institute was established in 1953. Originally designated as the Laboratory of Water Management its present name dates from 1 January, 1958. In the early phase the emphasis of research was based on investigations by physical scale models. Later non-Newtonian liquids and disperse systems were studied.

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

The main research topics address

- Fluid mechanics and hydraulic transport at different spatio-temporal scales
- Flow in reactors, fluidization and sedimentation
- Multi phase flows and biological interaction
- Hydrological modelling of water resources changes caused by climate variability and by land-use changes
- Pollution of surface- and groundwater and atmospheric deposition
- Processes in stratified reservoirs

A clear mission is missing.

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

59 people are included in the graphics describing the age structure of the institute. The number of FTEs in research is given with 30 while in administration 14 FTEs are reported. The age distribution yields 26 persons between 25 and 40, 8 between 50 and 60 and six above 70 years. In general the age structure is satisfactory although there is a gap in the age between 40-50 years (senior researchers).

## **2. STRENGTHS AND OPPORTUNITIES**

Due to the fact that the age distribution, research topics and list of publications are the same for the institute as well as the team the conclusions, strength and weaknesses and recommendations are the same for both groups. The only difference in the documentation is in the staff size. Probably, the team did not include the economy and service dept.

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

The number of publications and the frequency of citations indicate that the research topics of IHD attract international attention.

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

The IHD has close collaboration with the Faculty of Technology in Zlin (Polymer centre), Czech Technical University; Faculty of Science at Olomouc University and several CAS institutions. Students from the Charles University and University of Chemistry and Technology in Prague have been recently contracted.

IHD is also a member of the network of Euro-mediterranean Network of Experimental and Representative Basins (*ERB*).

### **2.3 Comments on the age structure**

In general, staff capacity and age structure are satisfactory. There is a gap in medium aged (40-50 years) researchers.

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

In total about 110 papers were published. 35 were assessed in the first phase of the evaluation process from which 3 (8%) were ranked as world leading and 17 (~ 50%) as internationally excellent.

## **3. WEAKNESSES AND THREATS**

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

About 80% of the financial resources of IHD are provided as institutional funding. Some years ago it was about 70%. The rest is covered mostly by national grants. International grants contribute only a small percentage. Also income from national grants (GACR, ministries) and a few contracts has decreased. The latter contribute about 5 % to the overall budget.

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

There are some joint grant projects with Czech universities (Faculty of Technology, Zlin; Czech Technical University; Faculty of Science at Olomouc University) but, as indicated above, the total grants are quite limited. Thus, the collaboration will be also limited.

At the international level there exist several collaborative links with technical universities in Australia, UK, Germany, Japan, the Netherlands, Poland). But due to missing international grants the intensity of these links is questionable.

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

There are numerous teams and research groups. Some of these groups consist of one researcher. This is definitely insufficient.

### **3.4 Comments on the age structure**

The size of staff is not fully clear. It was mentioned that about 30 researchers work today at IHD. The FTE of technical workers is given for 2014 with 4,75 complemented by 5 administrative workers.

The age structure shows to clear peaks in the range between 25 and 35 years and between 50-60. In total 59 people are included in the age statistics.

## **4. RECOMMENDATIONS**

### **4.1 Re-organisation of the internal structure of the institute and departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units**

The administrative structure of the institute with two research depts. which cover two distinct research domains looks reasonable. The structure at the level below (research groups, teams, laboratories) is not clear and is probably not necessary because of a limited staff capacity.

Some groups consisted of one researcher only. Also, there is a broad overlap among the teams in research.

During the onsite visit the Institute of Hydrodynamics as well as the Team of Hydrodynamical Aspects of Fluid Mechanics had to be evaluated. The documents for both entities show a broad overlap in figures and statements. This is also an indicator that the structure of the institute should be streamlined.

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

Some years ago IHD had developed an interesting internal program to stimulate the frequency and level of publications as well to motivate scientists to apply for international research grants. The approach was based on a financial bonus system.

It worked well with respect to publications where in this evaluation period a substantial increase in both quantity and quality could be achieved but it failed with respect to fund raising at all. As a consequence the bonus system had to be cut step by step. Today about 80% of the budget is covered by institutional contributions from CAS and external funding is continuing to decrease. Especially the lack of international grants is considered as a deficit.

#### **4.3 External funding (international projects and national grants)**

The general impression, gained during the onsite visit, is that business as usual is the main objective in management and research. With respect to publications this attitude is justified but in several other aspects changes are needed. It is recommended that some targets (international projects, ratio of grants in relation to institutional funding) are externally defined for IHD and a supervised discussion process should be initiated within the institute about organisation, targets, research directions, and incentives.

### **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 institute has an excellent expertise in 3D numerical modelling of Navier-Stokes equations and in multi-phase flow processes. The principal topics are in

- Modelling of flow behaviour of viscoelastic liquids by means of differential constitutive equations
- Nanoscale hydrodynamics for nano-particle systems

- Flow behaviour of electro- and magneto-rheological materials, electrospinning of polymer solutions
- Coagulation of algal organic matter in water treatment process
- Adsorption of algal organic matter onto activated carbon in water treatment process
- Vortical structures in transitional and turbulent flows
- The mathematical theory of the viscous incompressible Navier-Stokes equations
- Solid particles-liquid mixture flow
- Variability of hydrological cycle components in changing environment

### ***Relevance in the national context***

IHD has executed some contractual and collaborative research with Czech institutions which has direct benefits for society and commercial partners. Altogether the revenues add up to 400 k€ within 2010-2014. As an example, the “development and use of new techniques for early warning system for flash floods” is one of the largest projects with about 115 k€ revenues.

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

About 110 papers were published compared to 42 in the previous evaluation period (2005-2009). From these 110 papers 35 were published in peer reviewed journals from which 3 (8%) were ranked in Phase I as world leading and 17 (~ 50%) as internationally excellent. 13 papers were published in the top quartile of AIS journals. As can be concluded from the citation frequency the papers gained attention in the scientific community.

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

In hydrodynamics the main emphasis is on aspects of fluid mechanics including laminar, transitional and turbulent flow regimes for both Newtonian and non-Newtonian fluids. The theoretical basis constitutes the 3-dimensional Navier-Stokes equations (NSEs). The application of the theoretical concept to multiphase flow considering solid, organic and polymer substances are seen as the main achievements during the last few years.

The hydrological research has been focused on long-term hydrological modelling under climatic changes and improved quantitative understanding of processes controlling the transfer of water and heat near the land surface, including soil-plant-atmosphere interactions.

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

In the past 10-12 PhD students were involved in the research activities of the IHD. This year 4 PhD are working at the institute. The majority of young researchers are female PhDs and Post Docs but most of them are on maternal leave at the moment.

## **5.3 Declaration on societal relevance**

IHD has executed some contractual and collaborative research with Czech institutions which has direct benefits for society and commercial partners. Altogether the revenues add up to 400 k€ within 2010-2014. As an example, the “development and use of new techniques for early warning system for flash floods” is one of the largest projects with about 115 k€ revenues.

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

Popularisation is not a big issue at the institute. Every year an open day is organised and the staff contributes also popular lectures during the science week organised by CAS. Some reports in public media (newspapers, TV, radio) are reported.

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

The institute has several international partners but the intensity of collaboration is quite difficult to assess. There exist no international collaborative research programs and no international scientists work at the institute.

At the national level the institute cooperates with several universities, namely with the polymer centre at the faculty of technology in Zlin, the Czech technical University and the faculty of sciences at university of Olomouc. Lectures are additionally delivered at Charles university and university of life sciences, Prague. PhD students come from these universities including the university of chemistry and technology, Prague.

The level and intensity of publications is quite high as can be seen from Phase I where from 34 evaluated papers 3 were ranked as world leading and further 17 as internationally excellent. From all 129 publications were placed in the two upper quartiles of AIS journals. These papers received attention by the international scientific community as can be seen from the frequency of citations.

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

The general development does not look very promising. The institutional budget is the main financial resources while national grants contribute about 25 %. Their share is decreasing in time. International grants are not relevant in the institute’s strategy although several international partners are listed.

With respect to research fields no changes are intended. The business as usual attitude dominated the discussions. On one side this position can be justified by the excellent publication record but the fund raising strategy should be substantially improved, especially at the level of international collaboration.

The staff size seems to be appropriate for the research activities. Perhaps the percentage of the administrative sector is somewhat too high. The age distribution indicates a gap in the sector of senior researchers (40-50 years age) but young researchers dominate.

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

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

The main research fields which were mostly initiated during the period 2010-2014 will be kept.

However, it is necessary to recruit young and skilled research workers from various institutions with the overall goal to support a multidisciplinary approach. Further, completion and renovation of experimental devices is necessary that would require financial resources.

In general, it should be possible to achieve these tasks but some motivation within the team and at the management level would be obligatory. To attract young scientists the links to the universities, especially at the graduate teaching level, must be improved and intensified. Further, the raising of external grants is seen as substantial.



## EVALUATION OF THE INSTITUTE OF HYDRODYNAMICS

### *Team of Hydrodynamical Aspects of Fluid Mechanics*

#### 1. INTRODUCTION

The documents provided for the institute (IHD) and for the team of hydrodynamical aspects of fluid mechanics overlap to broad extent complicating a discriminative evaluation. This refers to the description of the research topics, funds and grants, publications, and future plans.

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

The institute has two research depts. (dept. of mechanics of fluids and disperse systems, dept. of hydrology and the environment) and an administrative dept. The depts. are subdivided into research groups or laboratories.

Usually a team is composed around on one or several grants. It is unclear what the role of this team is, as it covers research topics which expand over the responsibility of the two depts.

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

Typical research activities refer to

- Multi-phase flow processes of different fluids including polymer melts
- Gas absorption and permeation through nano composites
- Influence of algal organic matter on water treatment plants
- Vortical structures in turbulent flow
- Influence of algal organic matter on water treatment plants
- Large time behaviour of global turbulent solutions to 3D Navier Stokes equations
- Variability of hydrological processes in a changing environment

From the team's name (hydrodynamical aspect of fluid mechanics) one would expect that it is a part of the dept. of mechanics of fluids and disperse systems but in the list of research topics also "variability of hydrological processes in changing environment" is included which obviously is in the responsibility of dept. of hydrology and environment.

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

34 people are included in the graphics describing the age structure of the team members. In total the team is composed by the end of 2014 by 15,05 researchers, 10,24 other workers and 6,62 PhDs, all expressed in full time equivalents (FTEs).

The age distribution yields 21 researchers between 25 and 40 years, seven between 50 and 60, and 4 are more than 70 years old. The group of researchers in the age between 40 and 50 is underrepresented with 1 scientist.

## **2. STRENGTHS AND OPPORTUNITIES**

Due to the fact that the age distribution is very similar, research topics and list of publications are the same for the institute as well as the team the conclusions, strength and weaknesses and recommendations are the same for both groups. The only difference in the documentation is in the staff size. Probably, the team did not include the staff from the economy and service dept.

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

The research is centred around hot topics very similar to those of the whole institute. The number of publications and the frequency of citations indicate that the research topics of IHD attract international attention.

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

The IHD and the team have close collaboration with the Faculty of Technology in Zlin (Polymer centre), Czech Technical University; Faculty of Science at Olomouc University and several CAS institutions. Students from the Charles University and University of Chemistry and Technology in Prague have been recently contracted.

### **2.3 Comments on the age structure**

In general, staff capacity and age structure are satisfactory. There is a gap in medium aged (40-50 years) researchers.

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

About 110 papers were published. 35 were published in peer reviewed journals from which 3 (8%) were ranked in Phase I as world leading and 17 (~ 50%) as internationally excellent.

### **2.5 Frequency and quality of publications**

Publication list is exactly the same for the institute and the team. About 110 papers were published. 35 were published in peer reviewed journals from which 3 (8%) were ranked in Phase I as world leading and 17 (~ 50%) as internationally excellent. It is interesting to learn that the majority of papers refer to water resources, mechanics and chemical engineering.

### **3. WEAKNESSES AND THREATS**

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

About 80% of the financial resources are provided as institutional funding. Some years ago it was about 70%. The rest is covered mostly by national grants. International grants contribute only a small percentage. Also income from national grants (GACR, ministries) and a few contracts has decreased. The latter contribute about 5 % to the overall budget.

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At the international level there exist several collaborative links with technical universities in Australia, UK, Germany, Japan, the Netherlands, Poland). But due to missing international grants the intensity of these links is questionable.

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The size of staff is not fully clear. It was mentioned that about 30 researchers work today at IHD. The FTE of technical workers is given for 2014 with 4,75 complemented by 5 administrative workers.

The age structure shows to clear peaks in the range between 25 and 35 years and between 50-60. In total 59 people are included in the age statistics.

### **4. RECOMMENDATIONS**

#### **4.1 Re-organisation of the internal structure of the institute and departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units**

The administrative structure of the institute with two research depts. which cover two distinct research domains looks reasonable. The position of the team in the management structure of the institute is unclear. The team works on topics which refer to both depts.

The documents for both entities show a broad overlap in figures and statements. This is also an indicator that the structure of the institute should be streamlined.

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

Some years ago IHD had developed an interesting internal program to stimulate the frequency and level of publications as well to motivate scientists to apply for international research grants. The approach was based on a financial bonus system.

It worked well with respect to publications where in this evaluation period a substantial increase in both quantity and quality could be achieved but it failed with respect to fund raising at all. As a consequence the bonus system had to be cut step by step. Today about 80% of the budget is covered by institutional contributions from CAS and external funding is continuing to decrease. Especially the lack of international grants is considered as a deficit.

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### **5. DETAILED EVALUATION**

The detailed evaluation of the institute and the team is more or less the same. A slightly different formulation of research topics is observed but the content is the same.

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

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

The team has an excellent expertise in 3D numerical modelling of Navier-Stokes equations and in multi-phase flow processes. The principal topics are in

- Constitutive modelling of flow behaviour of polymer melts, measurement of elongational viscosity
- Gas adsorption and permeation through nano-composite films based on a deformable entangled network of carbon nanotubes
- Electro- and magneto-rheological behaviour of smart materials, electrospinnability of polymer solutions
- Vortical structures in transitional and turbulent flows
- Large time behaviour of global turbulent solutions to the 3D Navier-Stokes equations
- The influence of algal organic matter on water treatment processes
- Solid particles-liquid mixture flow

- Variability of hydrological processes in changing environment

### ***Relevance in the national context***

The team has executed some contractual and collaborative research with Czech institutions which has direct benefits for society and commercial partners. Altogether the revenues add up to 400 k€ within 2010-2014.

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

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Modelling of polymer fluids is also quite interesting for the industrial sector.

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

Popularisation is not a big issue. Every year an open day is organised and the staff contributes also popular lectures during the science week organised by CAS. Some reports in public media (newspapers, TV, radio) are reported.

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

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With respect to research fields no changes are intended. The business as usual attitude dominated the discussions. On one side this position can be justified by the excellent publication record but the fund raising strategy should be substantially improved, especially at the level of international collaboration.

The staff size seems to be appropriate for the research activities. Perhaps the percentage of the administrative sector is somewhat too high. The age distribution indicates a gap in the sector of senior researchers (40-50 years age) but young researchers dominate.

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

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

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However, it is necessary to recruit young and skilled research workers from various institutions with the overall goal to support a multidisciplinary approach. Further, completion and renovation of experimental devices is necessary that would require financial resources.

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**Date:** February 28, 2016

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