

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 Thermomechanics of the CAS, v. v. i.

Fields, in which the Institute registered its teams:

Electrical engineering, electronic engineering, information engineering, Materials engineering, materials science and nanotechnology, Mechanical and civil engineering

Observer representing the Academy Council of the CAS: Jiří Chýla

Observer representing the Institute: Jaromír Horáček, substitute observer Miroslav Chomát

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 - Department D 1 - Fluid Dynamics; No. 2 - Department D 2 - Thermodynamics; No. 3 - Department D 3 - Dynamics and Vibrations; No. 4 - Department D 4 - Impact and Waves in Solids; No. 5 - Department D 5 - Ultrasonic Methods; No. 6 - Department D 6 - Electrical Engineering and Electrophysics

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

1. INTRODUCTION

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

Research departments, science library and scientific societies of the institute are located in Dolejškova 1402/5, 182 00 Prague 8. The field laboratory in Nový Knín is located in: Pod Mikulí 280, 262 03 Nový Knín. The Institute of Thermomechanics has several branch offices and joint laboratories at different universities: Centre of Mechatronics, joint centre with Brno University of Technology seated at Faculty of Mechanical Engineering, Technická 2896/2, 616 69 Brno, Centre of Power Engineering, joint centre with Czech Technical University in Prague, Faculty of Mechanical Engineering, Department of Fluid Dynamics and Power Engineering, Technická 4, 166 07 Prague 6 – Dejvice, Centre of Intelligent Systems and Structures, joint centre with VŠB–Technical University of Ostrava, Centre of Smart Systems & Structures, Institute of Thermomechanics of the CAS, v. v. i., A 751, VSB-TU Ostrava, 17. listopadu 15/2172, 708 33 Ostrava – Poruba, and Laboratory of Material Diagnostics in Pilsen, Veleslavínova 11, 301 14 Plzeň.

1.2 Brief history of the institute

The Institute was established in 1953 as the Laboratory of Mechanical Engineering of the Czechoslovak Academy of Sciences (CAS). In 1955, it was renamed as the Institute for Mechanical Engineering (also Mechanical Research Institute) and in 1962 as the Institute of Thermomechanics CAS. In 1964, the Aerodynamic laboratory in Nový Knín (30 km from Prague) was established.

1.3 Mission and research topics

The Institute conducts interdisciplinary basic research in fluid dynamics, thermodynamics, dynamics of mechanical systems, solid mechanics, interactions of fluids and solids, environmental aerodynamics, biomechanics, mechatronics, electrophysics, electrical machines, drives and power electronics and material diagnostics.

1.4 Staff size and full time equivalents age distribution

258 people were employed in the institute with the full-time equivalent of 184.1 people including 76.1 technical and administrative FTE workers in 2014. The demographic structure of employees is partially stabilized with a promising large fraction of young researchers.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The principal areas of the institutes research in 2010-2014 cover the topical problematic of fluid dynamics, thermodynamics, dynamics of mechanical systems, mechanics of deformable solids, material diagnostics, interdisciplinary problems (e.g. fluid-structure interaction, environmental aerodynamics, biomechanics, and mechatronics), and power electromechanical systems (with emphasis on electric machines, instruments and other equipment). These activities are important from both, scientific and industrial point of view.

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

The institutional budget contains a very good fraction of external financing. Institutional funds cover only 60% of the institute budget, 36% comes from different types of research projects and industrial contracts make 4% of the budget.

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

The Institute has a very good long-term collaboration with a number of industrial enterprises, including Skoda-Doosan, CZ, Wikov, etc., Strong ties with universities – Technical Universities in Prague (CTU), Liberec, Plzen and Brno, and Charles University in Prague and other institute of CAS (Institute of Physics, Institute of plasma Physics). The Institute collaborates with a number of renowned foreign universities and research centres, for example University of Besançon, University in Czestochowa and Technical University Hannover.

2.4 Position of the institute within the Czech scientific community and its international position

During more than a half of a century of the existence the Institute received a very good reputation within the Czech and international scientific community. This fact is supported by a large number of received research projects (in average more than 60 every year) and also the number of contracts with industrial partners. The Institute participates in a number of international projects including COST and Thematic Network of the European Union, ERCOFTAC and QNET-CFD knowledge bases, KONTAKT programme and partnership agreements of the Academy of Sciences of the Czech Republic.

2.5 Reasonability of the structure of the institute and the departments

The Institute is divided into six principal departments. Their disposition reasonably copy the heterogeneity of main research topics.

2.6 Comments on the age structure

In general the Institute has a beneficial and perspective high number of young researchers below 35 – 40 years.

2.7 Frequency and quality of publications

High frequency of publications with a reasonable number of high quality citations.

2.8 Patents and role in contractual work

Contractual research represents a substantial part of research activities of the Institute. The number of patents (10) is excellent.

3. WEAKNESSES AND THREATS

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

Limited participation in EU projects. Industrial contracts make only 4% of the budget. However, this fact reflects the present situation on the market in Czech republic and ability of Czech companies to invest into a research.

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

Although the institute has a broad international collaboration the amount of financial support coming from EU resources or international projects is very poor.

3.3 Comments on the age structure

Low fraction of researchers between 45-60 years, which is even more pronounced in several cases at the level of departments and laboratories might be certainly a threat in the next period for the continuation of present research directions.

3.4 Frequency and quality of publications

Although the frequency of publications is relatively high, in several departments the number of publications in prestigious journals with IF represents only a very low fraction of the total number of publications.

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 Institute should face the problem of not very homogeneous age composition of the staff and the gap in the number of researchers of the age between 45 – 60 years. A programs on the level of Academy of Sciences of the type “Návrat” or similar internal programme might be of a great help. The Institute should also consider a partial reorganization of laboratories with a critical number of research workers.

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

The Institute should consider internal incentives supporting the transformation of conference contributions into regular articles in journals with IF increasing thus its international prestige, which might enhance the probability of finding of international partner, which can help with the location of international support.

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 principal areas of activities of the institute during the evaluated period were analytical, experimental and numerical investigations of fluid dynamics, thermodynamics, dynamics of mechanical systems, mechanics of deformable solids, material diagnostics, interdisciplinary problems, and power electromechanical systems.

Relevance in the national and international context

High number of contributions on international conferences broad international collaboration and very high number of project mainly from CSF proves the relevance both in the national and international context.

Overall quality of publications

Within the 391 outputs evaluated during the first phase of the evaluation process 18 appear in high quality journals from the first decile and 73 in the first quartile. 18 outputs were classified as world-leading and 73 as internationally excellent. Nevertheless, very large fraction of publications appear in journals without AIS.

Specification of the main achievements

The main achievement during the evaluated period are thermodynamic properties of ionic liquids, mechanical properties of surface layers, mathematical and physical modelling of fluid-structure interaction in human vocal folds, fluidic pumps for extremely dangerous liquids, 3D atomistic simulation of fatigue behaviour of cracks in single crystal of bcc iron, mathematical modelling of martensitic microstructures, unique ultrasonic methods for investigation of the mechanical properties of solids and modern materials, new principle of measurement of composition of two-phase mixtures, computer simulations of airflow in oscillating human vocal folds, mechanical properties of microstructures in 'smart' magnetic alloys, theoretical and experimental modelling of generators of synthetic and hybrid synthetic jets, Finite element solution of stress wave propagation problems: dispersion analysis and development of novel methods, investigation of thermal plasma jet structure by generalized correlation dimension, surface tension of supercooled water: a refuted anomaly, ultrasonic characterization of acoustic metamaterials, experimental and numerical investigation of friction element dissipative effects in blade shrouding, new methods for diagnostics of operational wear and suppression of instabilities in plasma torches, micromechanisms of formation and motion of martensitic microstructures and their experimental verification.

Specification of the contributions of the team to publications

The majority of evaluated outputs was created with a decisive contribution of researchers of the Institute with reasonable contribution of co-authors from Czech and international research teams. Within the Institute a decisive contribution of the Department of Thermodynamics to the total number of contributions in journals with IF should be mentioned.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The institute collaborates with several Czech universities (Charles University in Prague, Czech Technical University in Prague, Technical University in Liberec, Technical University in Brno and University of West Bohemia in Pilsen). The total number of student taking the research during the evaluated period was 109 (41 Ph.D., 32 master theses and 26 bachelor theses).

Number of defended PhD students in relation to students involved (success rate)

During the evaluated period 26 Ph.D. these were defended.

Employment of former PhD students (career options)

The strategy of acquisition of research scientists in the Institute of Thermomechanics revolves around the development of its own talented graduate and post-graduate students to produce and select new post-doctoral researchers. Considering the current absence of the market with researchers in the Czech Republic, this to achieve sufficient personnel variation in the research teams. Right from the beginning the post-doctoral researchers are provided with the opportunity to conduct independent research taking into account their individual ambitions. The post-doctoral researchers are encouraged in grant competitions. During 2010-2014 the post-doctoral researchers received 12 grants. Each year several other post-doctoral researchers are supported with internal pilot grants and 3 best post-doctoral researchers received special funding for outstanding talents from the Czech Academy of Sciences.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Institute has broad contacts with industrial partners often within the frame of contractual research. The most important partners are for example Doosan Škoda Power, s.r.o., Visteon-Autopal, a.s., ČEZ, a.s., VAMET, s.r.o., ÚJV Řež, a.s., etc.

Impacts of the results and other activities on education

Members of the Institute directly participate on education of Ph.D. students at Charles University in Prague, Czech Technical University in Prague, Technical University in Liberec, Technical University in Brno, VŠB – Technical University of Ostrava and University of West Bohemia in Pilsen. Moreover they are members of councils of accredited doctoral studies.

During 2010-2014 the Institute participated in two projects of the ESF (European Social Fund) operational programme Education for Competitiveness: Otevřená věda III (Open Science III) and Otevřená věda Praha (Open Science Prague), focused on the methodical engagement of talented high-school students in science and research. The Institute provided internship programmes in different areas of research to several high-school students.

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

During the evaluated period members of the team worked as editors of 29 books and 2 periodicals.

Services for research (libraries, data bases, collections,..)

The Science Library of the Institute of Thermomechanics is a core public library with specialized library stock. The Science Library provides access to books and journals from its own stock and from the stock of other libraries in the Czech Republic and abroad. It also provides a full-featured interlibrary borrowing service. Titles and borrowings can be searched and ordered via internet. The library collects various information resources covering the basic needs of the scientific disciplines of its focus. The library offers online access to internet-

based information resources, scientific databases, and reference and citation databases. The physical library stock includes approx. 8,000 items.

In the years 2011 and 2012 (13 months) the Institute acted as one of 14 pilot project validators of the national EF-TRANS grant project (Efficient Knowledge Transfer) of the Ministry of Education, Youth and Sports. The purpose of the project was to test, validate and develop best practices for knowledge transfer in research institutions in the Czech Republic.

Popularisation and similar activities

Every autumn the Institute of Thermomechanics opens its gates to the general public and welcomes its visitors with a range of exciting lectures, short excursions to its laboratories, and interactive and hands-on experiments. The Open Days were held in the Institute's laboratories in Prague, Nový Knín and Pilsen in 2010 and 2014 and in Prague and Nový Knín in 2011 and 2012. The approximate number of visitors is 250 every year, which includes mainly students from secondary schools.

The Institute of Thermomechanics organized or took part in the following exhibitions and campaigns for the promotion of science in 2010-2014:

The exhibition "Aerodynamics for light and warmth at home" co-organized with Doosan Škoda Power s.r.o. and the Czech Academy of Sciences on Nov. 3-14, 2014 in Prague.

"Digitally interactive" poster presenting a selection of research exhibits in the Academia bookstore in Prague during the month of May 2013.

Presentation of photographs with science and research themes at the exhibition "Science Backstage" in the iQpark Science Centre in Liberec on Sept. 23-Dec. 31, 2012.

The medium-voltage frequency converter 'INVERT' developed in collaboration of ČKD Elektrotechnika a.s. and the Institute was exhibited at the 19th Intl. Trade Fair of Electrotechnics and Electronics (AMPER 2011) held in the Brno Exhibition Centre on 29. 3.–1. 4. 2011 and received the GOLDEN AMPER AWARD from the Expert Committee.

Presentation of the Institute's research at the poster exhibition "Den firem pro fyziku 2014" held on April 29, 2014 at Charles University in Prague.

The scientists have been interviewed or featured in 7 television broadcasts and 8 radio broadcasts presenting the results of their applied research

The scientists of the Institute presented the following science popularization lectures:

- "How insects fly" 3 talks in 2011-13 by R. Dvořák for the Czech Union of Nature Protection
- "Vibration makes problems but can also be useful" by J. Kozánek, Open Days 2011
- "Mobile robotics" by J. Krejsa, Open Days 2011
- "Flow of fluid in miniature devices" by V. Tesař, Open Days 2011.

The scientists from the Institute published 17 articles in printed or online media for science popularization.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The Department holds important position both in national and international scientific community. Researchers of the Department are members of many relevant scientific societies, committees, boards, commissions, international associations etc.

Role and position in international collaboration

International collaboration is intensive and in general in the form of long and short term stages at foreign institutes.

Ability to attract foreign researchers at different levels

The ability to attract foreign researchers and students is not limited by the scientific reputation of the institute but by (in general) a low range of wages in comparison with modern developed countries. Nevertheless, the Institute is able to attract former Czech students after their return from long-term stages abroad.

Position of the team in the national context

The team belongs to leading research institute in the Czech Republic with a rich collaboration between particular institutes of CAS v.v.i., Czech universities and similar institutes worldwide.

5.5 Declaration on the vitality and sustainability

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

The research team is composed by highly educated and erudite research workers with a large fraction of young researcher below 40 years. The age composition suffers, however, by a noticeable gap between 45-60 years and relatively high fraction of researchers in the age of retirement. This reality might have a significant influence on a continuation of the research in the present extent.

Attraction of research programmes for young people

Strong ties of the Institute with universities and unique equipment makes the Institute very attractive and at present the Institute educates more post-graduate students and post-doctoral researchers than is actually needed.

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

Incomes from external funds are an integral part of funding of the Institute. Works on more than 60 projects were done each year. The majority (~30) comes from Czech Science Foundation. Increasing trend in the support comes also from Technological Agency of CR. The number of EU projects and incomes were very low (just only two projects in the first two years of the evaluated period).

Effectiveness of research (based on comparing size of groups, funding and output)

The effectiveness of the research performed at the Institute is reasonably high. More attention should be paid to improving the number of publication in journals with IF, which is also required by the major Czech funding agency.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

Organisational structure of the institute is typical within the CAS and is reasonably adequate for the management of the institute. The strategy of acquisition of research scientists in the Institute of Thermomechanics revolves around the development of its own talented graduate and post-graduate students to produce and select new post-doctoral researchers.

The career development of the research scientists is governed by the Career System of the Czech Academy of Sciences and the Wage Directive of the Institute of Thermomechanics. At least once in 5 years every researcher undergoes the assessment process overseen by the Attestation Commission of the Institute. The members of the Commission include external evaluators. Based on the recommendations of the Attestation Commission the Director of the Institute updates the qualification and wage categories of the employees. The granting of the highest qualification category to an employee must be approved by the Coordinating Commission appointed by the Czech Academy of Sciences. The Commission has Academy-wide competence and ensures that only employees with excellent achievements are granted the highest qualification category. The attestation process includes extensive evaluation of each employee. Beside the attestation process the employees are evaluated annually on the Institute level by a committee consisting of the Director, the Vice-directors and the Head of the research team of the employee. Further evaluations can be conducted by the heads of research teams as needed.

The remuneration policies put emphasis on the individual performance. In 2014 the average bonuses accounted for more than 30% of the nominal wages, which is high above the standard in the Academy. The researchers publishing in journals with impact factors are also rewarded with special bonuses. The amount of the bonus is governed by an internal regulation and increases with the quality of the journal. The employees can easily determine the bonus from the regulation, which motivates them to publish in the best possible journals. Successfully completed grants and research contracts and national and international patents are also rewarded with bonuses. The managerial quality of the team leaders and their ability to achieve objectives set out for their teams is also evaluated regularly.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

The research carried out in the Institute will continue in the same main research areas as in the previous period as mentioned in the section 5.1.

A growing number of the activities of the Institute of Thermomechanics (IT) are related to “Strategy AV21”, an initiative by the Czech Academy of Sciences (CAS) aiming to strengthen its role as an independent provider of expertise and research capacity to industrial as well as public sectors. IT is the leading institute during the development of the program

“Efficient Energy Conversion and Storage”, one of the 14 programs of the Strategy AV21. Dr. Plešek, the director of IT, has been appointed as the coordinator of the program, which includes 17 participating institutes of the CAS. The topics of the program are “Nanostructured materials for energy conversion”, “Efficient utilization of renewable energy sources”, “Storage of energy from renewable energy sources”, “Decentralized production and smart distribution of energy”, “New fuels for efficient and clean combustion”, “Enhanced efficiency and reliability of thermal power stations”, “Diagnostics and control of energy conversion processes”. IT is the leading institution in two topics of the program: thermal power stations and energy storage.

Adequacy of available means and human resources to achieve these plans

The Institute policy guarantees sufficient personal resources for a further development. The structure of financial sources of the Institute can raise some problems for the sustainability in next years since it is more and more based on competitive grants with relatively small financial subsidies limiting thus long-term investment..

Missing issues in the strategy

No particular strategy for the improvement of financing from EU funds is mentioned

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No. 1: Dept. D1 Fluid Dynamics

1. INTRODUCTION

Department of fluid dynamics is situated in the main building of the Institute of Thermomechanics CAS, in Dolejšková 5, Prague 8.

Research activities of Department of fluid dynamics are focused on fundamental theoretical and experimental studies in fluid mechanics, mainly internal aerodynamics, transitional and turbulent shear flows, and computational fluid dynamics including aspects of external and environmental aerodynamics and modelling of atmospheric flows, dispersion and environmental and wind engineering problems and processes. The department consists of four laboratories - Laboratory of internal flows, Laboratory of turbulent shear flows, Laboratory of environmental aerodynamics, and Laboratory of computational fluid dynamics.

The number of researchers is 29 with FTE in 2014 22.55 and 23 other researchers with FTE 6.95 in 2014.

The scientific team has 29 persons below 40 years, 13 persons below 50 years and 11 persons above 50 years.

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

Department of fluid dynamics is situated in the main building of the Institute of Thermomechanics CAS, in Dolejšková 5, Prague 8. The department consists of four laboratories - Laboratory of internal flows, Laboratory of turbulent shear flows, Laboratory of environmental aerodynamics, and Laboratory of computational fluid dynamics.

1.2 Mission and research topics

Research activities of Department of fluid dynamics are focused on fundamental theoretical and experimental studies in fluid mechanics, mainly internal aerodynamics, transitional and turbulent shear flows, and computational fluid dynamics including aspects of external and environmental aerodynamics and modelling of atmospheric flows, dispersion and environmental and wind engineering problems and processes.

1.3 Staff size and full time equivalents age distribution

The number of researchers is 29 with FTE in 2014 22.55 and 23 other researchers with FTE 6.95 in 2014.

The scientific team has 29 persons below 40 years, 13 persons below 50 years and 11 persons above 50 years.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The department deals with a modern topic combining theoretical studies with numerical modelling and experimental studies with a direct impact on industrial applications.

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

Significant financial support from external funds contributes a very good portion of contractual funding.

2.3 The overall capacity of staff

The aggregate number of FTE of researchers has a very good increasing tendency. The research staff is supported by an adequate number of supporting other workers.

2.4 Comments on the age structure.

Very good age structure of the scientific team with increasing number of FTE of members including young researchers makes a promising background for the future development of the department.

2.5 Patents and role in contractual work

Contractual work is a source of significant incomes.

3. WEAKNESSES AND THREATS

3.1 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Limited involvement into international projects

3.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Nearly no incomes from international funds.

3.3 Position of the institute within the Czech scientific community and its international position

The team belongs to leading group at the national level. on the international level belongs among institutes of average range taking into account the number of contributions in prestigious journals. Poor ratio of publications in journals with impact factor with respect to contributions in conference proceedings.

3.4 Frequency and quality of publications

Poor ratio of publications in journals with impact factor with respect to contributions in conference proceedings. In average less than two publications in journals with IF per one FTE researcher during five years is rather a poor number. The impact of published results on international scientific community is very limited. No large collaboration outputs.

3.5 Patents and role in contractual work

No patents were supplied by the team.

4. RECOMMENDATIONS

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

Emphasis on contributions in high quality journals. internal programs and incentives to stimulate a conversion of results from conference contributions into regular journal articles. Focus on strengthening of international 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)

Main research activities are of both, theoretical and experimental character accompanied with numerical modelling, often with direct impact on industrial applications. Main results can be shortly divided into several groups, reflecting the division of the department into laboratories. The first important group deals with aerodynamics tests of turbine blade cascade and turbines in general. The second group is focused on the description and control of flow instabilities and turbulences. Third group is mainly devoted to atmospheric dispersion phenomena and the role of atmospheric boundary layer. Finally, the last group is connected mainly with the Laboratory of computational fluid dynamics and deals with the implementation and development of mathematical models and computer simulations of turbulent flow.

Relevance in the national and international context

Results were received within the frame of Czech research projects and international cooperation. Some of unique results have a direct impact to basic theory of turbulence.

Overall quality of publications

The majority of evaluated publications belongs to internationally and nationally recognized outputs. World leading outputs as well as large collaboration outputs are missing. Similarly, the number of outputs in world leading journals is limited and citations coming from best journals in the category are negligible.

Specification of the contributions of the team to publications

Typical for the majority of outputs is a high fraction of work done only by members of the team including experiments, calculations, theoretical background and interpretation with rather limited international or national collaboration.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Students are involved into the research of the institute within the frame of their bachelor, master and doctoral studies.

Particular contributions of students to research

Students generally work on topics of their supervisors.

Number of defended PhD students in relation to students involved (success rate)

During the evaluated period 8 theses were directly supervised by members of the team, 8 theses were co-supervised or consulted and 5 theses supervised by members of the team were defended (2 doctoral, 1 master and 2 bachelor).

Employment of former PhD students (career options)

Several former students, including female students, are now members of the research team.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Members of the team participate in decisions of major Czech Science Foundation mainly as members of Panels and Discipline Committee of Technical Sciences. Further on the national level they are members of the Accreditation Commission of the Czech Republic and work as a leading person in the Czech Pilot Centre of ERCOFTAC. Internationally they are involved in the work of Management Committee of COST ES1006 and are active in editorial boards of several journals and their active reviewers. The team has a broad collaboration with the industry and participate on solving of manufacturing problems of industrial partners and research institutes and universities within the frame of contractual research. The main partners are Doosan Škoda Power, s.r.o. and Visteon-Autopal, a.s. Main contribution of the team consist in the design, measurements and even realization of special parts and devices.

Impacts of the results and other activities on education

Actively they participate in educational bachelor, master and doctoral programs at Charles University in Prague, Czech Technical University Prague, University of West Bohemia Pilsen at several faculties.

Popularisation and similar activities

The team contributed to organization of international conference 'Topical problems of fluid mechanics' together with Czech and French university. The team regularly contributed to numerous popularization activities starting with activities for primary schools, through popularization exhibitions, educational movie 'Aerodynamics and drag', series of popularization lectures, contributions in Czech popularization journal Vesmir and annual organization of an international conference 'Topical problems of fluid mechanics'.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The team belongs to leading group at the national level with established collaborations with several Czech teams mainly at universities. The number of research projects funded by the Czech Science Foundation and TACR confirms this statement. However, on the international level belongs among institutes of average range taking into account the number of contributions in prestigious journals and scientific impact and response.

Role and position in international collaboration

The international collaboration is limited to program COST or direct exploitation of experimental facilities at different institutes.

Breadth/completeness of the research activities compared to world leading teams of comparable size

In comparison with leading European laboratories (Max Planck, ETH, etc.) with comparable number of researchers the output is significantly lower, which might be partially conditioned by a lower budget of the team.

Ability to attract foreign researchers at different levels

Incomparable financial conditions and moderate prestige of the institute limits significantly the possibility to attract foreign researchers including Ph.D. students from developed countries.

5.5 Declaration on the vitality and sustainability

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

The age structure of the team is of a very good distribution including students, young researchers, post docs, research fellows and senior researchers with the best qualifications reachable in the Czech

republic, which is further improved by a direct collaboration with foreign institutes. Nevertheless, the structure suffers from a lack of directly employed foreign researchers and Ph.D. students. Also the number of female researchers is low.

Attraction of research programmes for young people

Although the research uses a modern methods and unique facilities the department facilitates rather low interest of good new students. The limitations are of two origins. It is a general lack of interest of young generation in the research work with rather low salary (in comparison with a direct involvement in the industry) and lack of a high quality young Ph.D. students available for CAS (CAS could not directly supervise Ph.D. students and better ones are preferentially involved in the research at universities).

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

The structure of funds is balanced with a good contribution from contractual research (about 6%) and national resources.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

The future plans are connected with the work performed in 2010-2014 period. The main accent will be focused on topics covered by projects of the Czech science foundation proving the relevancy of the research. Contractual works for Doosan Skoda Power Company will continue. A significant strengthening of collaboration with universities and Czech research institutes is expected.

Adequacy of available means and human resources to achieve these plans

The number of young researchers in combination with the number of senior researchers is a good background, which can guarantees the achievement of goals declared in the research plan for the next period. The positive factor is that the team does not rely only on institutional resources but has a high probability of receiving support from other national resources.

Missing issues in the strategy

The missing issue in plans and strategy of the department is a lack of any attempt to be involved into a deeper international collaboration within international projects and to promote the interest of foreign researchers into the involvement in the research of the department.

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No.2: Dept. D2 Thermodynamics

1. INTRODUCTION

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

The department consists of three laboratories - Laboratory of Thermophysical Properties of Fluids, Laboratory of Heat and Mass Transfer, and Laboratory of Phase Transition Kinetics and is located in the main building of the Institute of Thermodynamics in Thermomechanics CAS, in Dolejškova 5, Prague 8.

1.2 Mission and research topics

The research in the Department of thermodynamics concerns various aspects of heat and mass transfer, fluid flow, material properties, phase transitions, and various complex processes requiring specialized, mostly self-designed, experimental apparatuses, thorough theoretical understanding and expertise in mathematical modeling. In the evaluated period, the research activities were primarily concentrated on thermophysical properties of interesting fluids such as new, eco-friendly refrigerants or ionic liquids, the changes of state of matter or phases of solid matter, such as nucleation in condensation and cavitation, synthesized and impinging pulsatile jets, blood circulation, flow in elastic blood vessels, and thermodynamic aspects of chemical reactions in the human body.

1.3 Staff size and full time equivalents age distribution

The number of researchers is 20 with average aggregate FTE in the year 2014 14.50 and the number of other workers 22 with the average aggregate FTE in the year 2014 6.35.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The department deals with highly actual topics of the conversion of heat energy into different forms of energy (and visa-versa) and its relation to macroscopic variables. The research in the Laboratory of Thermophysical Properties of Fluids (LTPF) focused on thermophysical properties of alternative environmentally safe refrigerants and of ionic liquids. Ionic liquids are currently subject of intense research efforts because of their remarkable potential for applications coupled with favorable environmental properties. An important field of study in the Laboratory of Heat and Mass Transfer (LHMT) were synthetic jets (SJ). SJ offers potential advantages for various applications of active

control of flow/thermal fields such as heat/mass transfer applications (drying technologies or cooling of highly loaded electronic devices or gas turbine blades). Main research activities of the Laboratory of Phase Transition Kinetics (LPTK) are connected with theoretical and experimental investigation of the thermophysical properties of metastable fluids, phase transitions, particularly nucleation of droplets and bubbles. These activities are important for example in atmospheric research and non-equilibrium condensation at turbine blades.

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

The department received strong financial support from external funds mainly from CAS, TACR and MEYS.

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

Good collaboration between laboratories, collaboration with the institute of Physical Chemistry of CAV and with universities and international collaboration.

2.4 Position of the institute within the Czech scientific community and its international position

The institute belongs to leading institutions in the field in the Czech Republic with good international recognition.

2.5 The overall capacity of staff

Stable number of FTE with significant support from other workers.

2.6 Reasonability of the structure of the department

Logic division of the department into three collaborating laboratories.

2.7 Comments on the age structure

Uniform age distribution of the research team with promising fraction of young researchers.

2.8 Frequency and quality of publications

High number of very high quality outputs in internationally recognized journals.

2.9 Patents and role in contractual work

Respectable number of patents (9) and applied results (13).

3. WEAKNESSES AND THREATS

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

Nearly no incomes from international funds and rather low incomes from contractual works.

3.2 Frequency and quality of publications

Missing large collaborations outputs.

3.3. Patents and role in contractual work

Rather low incomes from contractual work.

4. RECOMMENDATIONS

Focus on strengthening of international collaboration and stimulation of programs enabling to receive funding from international funds. Further focus on publications in the world leading quality journals.

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 main research activities are focused on equilibrium and non-equilibrium thermodynamics, heat and mass transfer, fluid flow, and other engineering science disciplines.

The work is of both, experimental and theoretical character accompanied with intensive modelling. A division of groups of results reflects the structure of the department. The research in the Laboratory of Thermophysical Properties of Fluids was focused on new generation of refrigerants defined by attention to global warming. Also the possible use of alternative approaches, especially absorption refrigeration, was investigated with the use of ionic liquids as absorbent. Models were developed of the dependence of the studied properties of ionic liquids on the anion and cation structure. Measurements of the surface tension-temperature and VT relation were performed for 9 and 14 ionic liquids, respectively. The constant volume PVT data are the only ones available in the temperature region below 273 K. This temperature region forms a specific part of the liquid range of ionic liquids, which has its own importance in applications such as the low temperature heat transfer medium and electrolyte, refrigeration, and low temperature tribological or hydraulic applications. Main activities of the Laboratory of Heat and Mass Transfer deals with synthetic jets, vortex shedding under non-isothermal conditions, creation of small gas bubbles in liquids and MEMS for mass sensors and viscosity sensors. Synthetic jets offers potential advantages for

various applications of active control of flow/thermal fields such as heat/mass transfer applications (drying technologies or cooling of highly loaded electronic devices or gas turbine blades). Vortex shedding is important for theoretical study of hydrodynamic instability and it is also important from the engineering point of view as one of the sources of the flow-induced vibrations, noise, or even a body collapse. It influences the drag as well as heat transfer in external flow. Results obtained in an effort to generate very small gas bubbles in a liquid, which are needed in a wide number of branches of process engineering. The most important among them is production of renewable automobile fuels from primitive plants – algae. Research activities of the Laboratory of Phase Transition Kinetics are connected with theoretical and experimental investigation of the thermophysical properties of metastable fluids, phase transitions, particularly nucleation of droplets and bubbles. The apparatus for measurement of the density of supercooled water has been designed, manufactured, and tested during the reporting period. Further research activities were motivated by the need of accurate modelling of non-equilibrium condensation in steam turbines. An analytical formulation for steam suitable for computational fluid dynamics (CFD) has been developed. Besides the investigation of the properties of fluid systems, numerous mathematical models in continuum mechanics and thermomechanics of solids have been developed.

Relevance in the national and international context

During the evaluated period unique data were received. Comprehensive property data are required not only for concrete applications, but they also form a fundamental knowledge base for further processing as the development of predictive schemes, formulations of thermodynamic properties and theoretical modeling. Results were created within the frame of Czech national projects but also within an international collaboration. Their relevance is supported by a high number of publication and patents.

Overall quality of publications

The number of publications in journals with IF is 118. Large portion of publications was published in the world leading journals or journals highly recognized by the scientific community. Nevertheless, the number of citation from high ranked journals is rather limited. Also large collaboration outputs are missing.

Specification of the contributions of the team to publications

Supplied results were completed mainly solely by members of the team with a good fraction of publications based on collaboration on both, national and international level.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Students are involved into the research of the institute within the frame of their bachelor, master and doctoral studies. During the evaluated period 13 theses were directly supervised by members of the team, 6 theses were co-supervised or consulted and 19 theses supervised by members of the team were defended (6 doctoral, 8 master and 5 bachelor).

Particular contributions of students to research

Students participated directly on the research mostly related to the research performed by the supervisor or co-supervisor, or they have performed experimental research in laboratories of the Department of thermodynamics.

Employment of former PhD students (career options)

Several former students from the department or from the institute are members of the research team.

5.3 Declaration on societal relevance

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

Members of the team participated on decisions of Grant Agency of Academy of Sciences and in the Research Council of Norway, Call Petromacs2. They are active members of scientific councils of Technical University in Liberec and Charles University in Prague. They work in editorial boards of Springer and Wiley publishers and as peer reviewers of numerous scientific journals. More than 250 peer reviews were elaborated during the evaluated period. Actively they work in World Council of Biomechanics and International Association for the Properties of Water and Steam in the Executive Committee or in Workgroups.

Impacts of the results and other activities on education

Members of the team directly participate on teaching at several Czech universities, namely at Charles university in Prague, Czech Technical University in Prague and Technical University in Liberec at several faculties. They were supervisors or co-supervisors of several bachelor, master and Ph.D. Theses. They also prepared lectures in three summers schools organized by Czech Technical University and Technical University in Liberec.

Popularisation and similar activities

The main popularization activity of the team is concentrated in the Days of Open Doors of the Institute of Thermomechanics where the department prepared several presentations. They also participated on popularization publication 'What Jules Verne did not know about supercooled water'.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The quality profile of the team is of very high range with results belonging to world-leading ones. From this point of view the institute is comparable with best institutes in Europe. Nevertheless, the impact of their work quantified by the number of citations from world leading journals is rather limited.

Role and position in international collaboration

The team has broad contacts with foreign laboratories for instance in Germany, Taiwan and India based on mutual convenience and also on unique experimental equipment, model concepts or software packages. Results of this collaboration appeared in shared publications and patents.

Breadth/completeness of the research activities compared to world leading teams of comparable size

The department possess own unique experimental facilities and highly recognized persons working on theory and computer modeling which makes the department a compact unit comparable with world leading teams.

Ability to attract foreign researchers at different levels

Incomparable financial conditions of the institute in the international scale limit significantly the possibility to attract foreign researchers including Ph.D. students from developed countries. Nevertheless, the department is able to attract back their former students after their post-doc stays on reputable institutions.

Position of the team in the national context

The team belongs to leading group at the national level with established collaborations with several Czech teams mainly at universities. The number of research projects funded by the Czech Science Foundation and TACR confirms this statement.

5.5 Declaration on the vitality and sustainability

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

The age structure of the team is of a very good distribution including students, young researchers, post docs, research fellows and senior researchers with the best qualifications reachable in the Czech Republic, which is further improved by a direct collaboration or long-term stays in foreign institutes. Nevertheless, the structure suffers from a lack of directly employed foreign researchers and Ph.D. students. Also the number of female researchers is rather low. This fact is however, a reflection of general situation in natural and technical sciences.

Attraction of research programmes for young people

Although the research uses a modern methods and unique facilities the department facilitates rather low interest of new students. The limitations are of two origins. It is a general lack of interest of young generation in the research work with rather low salary (in comparison with a direct involvement in the industry), and a lack of a high quality young Ph.D. students available for CAS (CAS could not directly supervise Ph.D. students and better students are preferentially involved in the research at universities).

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

Large portion of incomes originated from external funds, especially from the Czech Science Foundations. Incomes from contractual research are rather low and they reflect the generally low involvement of the Czech industry in direct financial support of the research. Incomes from international founding organizations are missing.

Effectiveness of research (based on comparing size of groups, funding and output)

The quality and number (around 1.5 publication with IF per one FTE per year) of scientific and applied results corresponds well with the number of researchers of the team.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The structure of the department as a whole fits well with the management of modern institutions. The age distribution of researchers and involvement of young researchers confirms a proper choice of recruitment method. Lower number of female researchers and international researchers is a reflection of general Czech social conditions.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

In the coming years, the team will continue the research directions which proved to be fruitful at present. The preferential topics, which show growing interest worldwide, will be the properties of new ionic liquids, new configurations of synthetic jets for enhanced heat and mass transfer or flow control, metastable states and non-equilibrium phase transformations at high temperatures and/or pressures. Besides that, new topics will be started, some of them motivated by the Strategy AV21, such as background physics of metal 3D printing or properties of new materials for thermal energy storage.

Besides the existing laboratories LTPF, LHMT, and LPTK, it is considered that a new laboratory will be established to replace the Laboratory of Biological Fluids, which practically ceased to exist. It is assumed that the new laboratory will focus on various principles of energy storage. This topic developed from the recent involvement of the department head in the Strategy AV21, particularly in program Efficient Energy Conversion and Storage. It is also considered that this topic would lay in the intersection of the existing laboratories and contribute in this way to the integrity of the team.

Adequacy of available means and human resources to achieve these plans

The department possess unique devices and high number of young researchers which together with experienced senior researchers is a guarantee of achievement of declared goals. The only threat might be the under-financing of the research in the country which generally results in a lower probability of receiving the support from external resources.

Missing issues in the strategy

The missing issue in plans and strategy of the department is a lack of any attempt to be involved into a deeper international collaboration within international projects and to promote the interest of foreign researchers into the involvement in the research of the department.

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No.3: Dept. D3 Dynamics and Vibrations

1. INTRODUCTION

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

The department consists of three principal laboratories -Laboratory of Modelling and Identification of Dynamic and Mechatronic Systems, Laboratory of Laboratory of Vibrodiagnostics and Nonlinear Dynamics, Laboratory of Modelling of Multiphysical Problems, and one Experimental Laboratory of the department. The department is located in the main building of the Institute of Thermodynamics in Thermomechanics CAS, in Dolejškova 5, Prague 8.

1.2 Mission and research topics

Basic theoretical, numerical and experimental studies on vibration of mechanical systems, identification and vibrodiagnostics of complicated and non-linear dynamic systems, and on fluid – structure interaction problems including vibroacoustics.

1.3 Staff size and full time equivalents age distribution

The number of researchers is 20 with average aggregate FTE in the year 2014 14.13 and the number of other workers 12 with the average aggregate FTE in the year 2014 4.55.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The department is doing world leading and internationally excellent research focused on the identification and tuning of complicated and mechatronic dynamical systems, methods of monitoring vibrations and dynamic loading of machine elements and development of methods for the study of problems with respect to the interaction of flowing fluids and deformable bodies and their experimental verification in aerodynamic tunnels.

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

The department received strong financial support from external funds mainly from CAS, TACR and also from contractual research.

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

Good collaboration inside the institute and with Czech universities.

2.4 Position of the institute within the Czech scientific community and its international position

The institute belongs to leading institutions in the field in the Czech Republic with excellent international recognition supported by several citations from highly ranked journals.

2.5 The overall capacity of staff

Stable number of researchers with increasing FTE.

2.6 Reasonability of the structure of the institute and the departments

Reasonable division of the department into collaborating laboratories with shared Experimental laboratory.

2.7 Patents and role in contractual work

Contractual work is a source of significant incomes.

3. WEAKNESSES AND THREATS

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

Incomes coming from international funds are limited to direct contractual research.

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

Rather low intensity of international collaboration.

3.3 Comments on the age structure

Non-uniform distribution with lower fraction of young researchers below 35 years.

3.4 Frequency and quality of publications

Poor ratio of publications in journals with impact factor with respect to contributions in conference proceedings and other journals. In average less than 2.5 publications in journals with IF per one FTE researcher during five years is rather a poor number. No publications in the first decile, limited impact on the international scientific community. No large collaboration outputs. Missing publications in journals from the first decile.

3.5 Patents and role in contractual work

No patents supplied by the team during the evaluated period.

4. RECOMMENDATIONS

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

Emphasis on contributions in high quality journals, internal programs and incentives to stimulate a conversion of results from conference contributions into regular journal articles. Focus on strengthening of international collaboration and focus on international projects financed by external european funds. Deeper collaboration with universities in order to receive young students.

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 Laboratory of Modelling and Identification of Dynamic and Mechatronic Systems is engaged in the identification and tuning of complicated and mechatronic dynamical systems, the development of mathematical and physical modelling methods for these systems, and their optimisation. The mathematical models are considered either linear with the corresponding spectral and modal characteristics or weak and stronger nonlinear. Applications are found in the dynamics of machines with an emphasis on rotational machines with both classic and contactless bearings and various physical fundamentals, e.g. modelling and stability of airfoils.

The Laboratory of Vibrodiagnostics and Nonlinear Dynamics is primarily engaged in the methods of monitoring vibrations and dynamic loading of machine elements during rotation, the vibrodiagnostics of rotating machines, the vibroacoustic properties of mechanical systems, and numerical simulations of the vibrations of nonlinear systems. Dynamic behaviour with thermo-mechanical coupling is modelled for damping elements made of thermoviscoelastic materials. The stability of motion, the regions of chaotic and irregular motions, and the nonlinear interaction of oscillating dynamical systems with a source of vibration energy and external electromechanical systems, are primarily under study in the numerical simulation of nonlinear mechanical systems.

The Laboratory of Modelling of Multiphysical Problems is engaged in the development of methods for the study of problems with respect to the interaction of flowing fluids and deformable bodies and their experimental verification in aerodynamic tunnels. The vibration characteristics and stability limits of aerohydroelastic systems are studied. Attention is also given to the modelling of acoustic-structural couplings of vibrating bodies in interaction with acoustic media and the modelling of aeroelastic interactions in the biomechanics of the human

voice. The source vocal soundwaves, i.e. the self-excited oscillations of the vocal cords excited by an airstream from the lungs, and the acoustic pressure modified by the frequency-modal characteristics of the human vocal tract during the phonation of vowels is modelled. The whole department shares the Experimental Laboratory

Relevance in the national and international context

Results were received mainly within the frame of Czech research projects and collaboration with laboratories in France and work for university in Finland. The evaluated outputs belong in majority to internationally excellent and recognized ones, minor number belongs to nationally recognized ones. One was evaluated as world-leading.

Overall quality of publications

The number of publications in journals with IF is 35. Large portion of publications was published in the world leading journals or journals highly recognized by the scientific community. Nevertheless, the number of citation from high ranked journals is rather limited. Also large collaboration outputs are missing.

Specification of the main achievements

The research of the department copies the orientation of particular laboratory. Shortly they are the identification and tuning of complicated and mechatronic dynamical systems, spectral properties and identification of aerostatic bearings, the limitation of the lateral vibration of rotors with rolling-element bearings passing through critical speeds, vibration amplitudes of a rigid rotor damped by magnetorheological squeeze film dampers, the flow field acting on the fluttering profile and ultrathin films utilizing micro and nanoresonators for Laboratory of Modelling and Identification of Dynamic and Mechatronic Systems. Dynamical behavior of rotary bladed wheels, condensed mathematical model of the bladed disk, multipoint electromagnetic impulse excitation, the friction effect and wheel mistuning on the dynamic behavior of bladed wheels, new methods in vibrodiagnostics of turbine blades, new methods of contactless vibration monitoring, etc. for Laboratory of vibrodiagnostics and nonlinear dynamics. The work of the research team of the Laboratory of Modelling of Multiphysical Problems was mainly concerned with fluid-structure interaction problems in aeroelasticity and in biomechanics of human voice.

Specification of the contributions of the team to publications

Supplied main results in journals with IF were completed mainly solely by members of the team. Only three evaluated works arised from international collaboration.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Students are involved into the research of the institute within the frame of their doctoral studies. During the evaluated period 4 Ph.D. students were supervised by members of the team and four thesis were defended.

Particular contributions of students to research

Students participated directly on the research located at the department.

Employment of former Phd students (career options)

Former students from the department or from the institute are members of the research team.

5.3 Declaration on societal relevance

Impacts of the results and other activities on education

Members of the team directly participate on teaching at several Czech universities in bachelor, magister and doctoral programs.

Members of the team are members of doctoral boards at West Bohemia University, Czech Technical University in Prague, Brno University of Technology, Technical University, Liberec.

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

Members of the team are active members of committees and councils of international and national societies and universities (International technical committee Vibration in the world federation IFTOMM, committee of the Czech Society for Mechanics, national section of the GAMM, Institution councils of IT AS CR, v.v.i. and ITAM AS ČR, v.v.i., General Assembly of the Academy of Sciences of the Czech Republic, Scientific Council of the Czech Technical University in Prague, Faculty of Civil Engineering, CAS Commission for Defending Research Professor Theses in Theoretical and Applied Mechanics, International technical committee Rotordynamics IFTOMM, Main committee of the Czech Society for Mechanics, Research committee of Applied mechanics, VŠB – Technical University Ostrava, Research committee of Applied mechanics, Faculty of Mechanical Engineering, Technical University, Žilina, etc. They are also involved into a reviewing of journal papers of several scientific journals and they are members of editorial boards of journals.

Popularisation and similar activities

Members of the team were active members of Scientific Committees and Organizing Committees of international conferences, symposia and colloquia. They have also been

interviewed or featured in 3 television broadcasts and 1 radio broadcasts presenting the applied results of their applied research

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The quality profile of the team is of very high range with results belonging to world-leading and internationally excellent. From this point of view the institute is comparable with best institutes in Europe. Nevertheless, the total number of highly ranked works and the impact of their work quantified by the number of citations from world leading journals is rather limited.

Role and position in international collaboration

Direct international collaboration is rather limited. The team was not involved directly into any international project. The collaboration is often reduced to personal contacts with members of foreign teams.

Breadth/completeness of the research activities compared to world leading teams of comparable size

The department possess own unique experimental facilities and highly recognized persons working on theory and computer modeling which makes the department a compact unit comparable with world leading teams.

Ability to attract foreign researchers at different levels

Incomparable financial conditions of the institute in the international scale limits significantly the possibility to attract foreign researchers including Ph.D. students from developed countries. Nevertheless, the department is able to attract back their former students after their post-doc stays on reputable institutions.

Position of the team in the national context

The team belongs to leading groups at the national level, both in fundamental research and modelling as well as in the applied research.

5.5 Declaration on the vitality and sustainability

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

The age structure of the team is not uniform. The number of young researchers below 35 years and the number of researchers between 48-60 is relatively low in comparison with other categories. Number of female researchers is lame. Qualification and international experiences of very good quality. The structure suffers from a lack of directly employed foreign researchers and Ph.D. students.

Attraction of research programmes for young people

Although the research uses modern methods, computer simulations and unique facilities the department facilitates rather low interest of new students. During the evaluated period no bachelor or master thesis was solved at the department. The limitations are of two origins. It is a general lack of interest of young generation in the research work with rather low salary (in comparison with a direct involvement in the industry), and a lack of high quality young Ph.D. students available for CAS (CAS could not directly supervise Ph.D. students and better students are preferentially involved in the research at universities).

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

Good part of incomes arises out of external funds (mainly CSF) and contractual research. Incomes from international founding organizations are missing.

Effectiveness of research (based on comparing size of groups, funding and output)

Average number of about 0.5 publication/year/1FTE in journal with IF is not sufficient for a team of such a quality.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The structure of the department is similar to other departments and is of acceptable composition. System of incentives for persons recruiting young students and foreign researcher might be of help.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

The research plan for the next five years stems in majority from works performed in the previous period. New directions will be promoted also with the use of newly acquired Laboratory of rotary laser vibrometry financially supported by the Operational Programme Prague Competitiveness

Adequacy of available means and human resources to achieve these plans

The department possesses unique devices and experience in experimental, theoretical and computational research of phenomena connected with vibrations. One of positive factors is sufficiently high financial support from external sources.

Missing issues in the strategy

The missing issue in plans and strategy of the department is a lack of any attempt to be involved into a deeper international collaboration within international projects and to promote the interest of foreign researchers into the involvement in the research of the department.

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No. 4: Dept. D4 Impact and Waves in Solids

1. INTRODUCTION

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

The department consists of three principal laboratories - Laboratory of Computational Solid Mechanics (LCM), Laboratory of Non-Destructive Testing (LNDD) and Laboratory of Material Diagnostics (LMD). First two laboratories are located in the main building of the Institute of Thermodynamics in Thermomechanics CAS, in Dolejšková 5, Prague 8, LMD is located in Veleslavinova 11 in Pilsen.

1.2 Mission and research topics

Activities of the department cover theoretical, numerical and experimental research of dynamical processes in solids; investigation of transient and wave phenomena in solids; impact and contact problems; phenomenological description of material behaviour and experimental verification; computational methods in continuum mechanics, fracture/damage analysis, and non-destructive testing and characterization of materials and structures.

1.3. Staff size and full time equivalents age distribution

The number of researchers is 17 with average aggregate FTE in the year 2014 11.45 and the number of other workers 30 with the average aggregate FTE in the year 2014 7. The age structure of the department is characterized by a large fraction of young researchers supported by a strong group of senior research workers.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The department is doing a world leading and internationally excellent research focused on theoretical disciplines (theoretical and continuum mechanics, theory of wave propagation, fluid-structure interactions, parts of solids state physics, computational material science), mathematical modelling, topical numerical methods and numerical mathematics (finite element method and its modern versions, methods of molecular dynamics, solution of linear and nonlinear problems, efficient solvers, developing proprietary finite element code PMD and parallel code for molecular dynamics), and

experimental methods (based on mechanical testing, acoustics, ultrasonics, optics, and complex structural health monitoring).

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

The department has a strong financial support from external sources, mainly originating from Czech Science Foundations and projects financed directly by MIT and MEYS. The department has also reasonable revenues from contractual research.

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

Good collaboration inside the institute and intensive collaboration with other Czech institutes and universities and international partnership.

2.4 Position of the institute within the Czech scientific community and its international position

The institute belongs to leading institutions in the field in the Czech Republic with excellent international recognition and collaboration.

2.5 The overall capacity of staff

Good number of supporting other workers.

2.6 Reasonability of the structure of the institute and the departments

Reasonable division of the department into collaborating laboratories.

2.7 Comments on the age structure

Promising fracture of young researchers.

2.8 Frequency and quality of publications

Excellent and world leading quality of outputs.

2.9 Patents and role in contractual work

One patent sheared with other departments and moderate number of contractual work with applied results.

3. WEAKNESSES AND THREATS

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

Direct financial support from international funds is missing.

3.2 Position of the institute within the Czech scientific community and its international position

International reputation is not supported by direct financial support from European or other international funds.

3.3 The overall capacity of staff

Decreasing number of average aggregated FTE (nearly by 40 % during the evaluated period) might be a threat for the further development and sustainability of the department.

3.4 Frequency and quality of publications

Although the quality of supplied outputs belongs to excellent ones the number of contributions in journals with IF is not too high (~ 2 publications per one average FTE during 5 years). Also citations from highly recognized journals from the first decile are missing. No large collaboration outputs.

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

Stabilization of the number of the team. Reorganization within the department does not solve the problem with decreasing number of FTE. Attraction of people with experience from abroad (not necessarily foreigners) using for example programs supported by the Academy of Sciences or MEYS (programs of the type *Návrat*) might be of help.

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

Internal programs and incentives to stimulate a conversion of results from conference contributions into regular journal articles in prestigious journals are highly recommended.

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)

Main results of the department may be divided into several groups. The first one contains finite element and isogeometric analysis of stress wave propagation, dispersion analysis and development of novel methods for contact-impact problems and FE software PMD. The second group of results is focused on fatigue damage of materials and analytical and semi-analytical approaches in wave phenomena in solids. Further groups of results deal with development of advanced computational models in phenomenological plasticity, 3D atomistic

simulations by molecular dynamics in fatigue crack propagation in metallic materials, numerical methods for solving very large FEM problems - application of domain-decomposition methods in computational elasticity and fluid mechanics, acoustic emission source location and identification, diagnostics of helicopter gearbox by continuous acoustic emission, nondestructive evaluation and imaging of material defects with nonlinear ultrasonic spectroscopy, structural health monitoring in aerospace and civil engineering supported with two ultrasonic NDT methods - AE and NEWS, noninvasive ultrasonic methods in diagnostics of biological materials and fatigue life prediction methods for a set of multiaxial experimental data on broad-band random loading.

Relevance in the national and international context

The relevance of results is supported by numerous international collaborations and large number of projects and contractual works. Results were published in world leading journals and served as a background for industrial applications and one patent.

Overall quality of publications

Large portion of publications was published in the world leading journals or journals highly recognized by the scientific community. The impact on the scientific community measured by the number of citations from high ranked journals confirms this statement, although citations from journals from the first decile are missing.

Specification of the contributions of the team to publications

Supplied results were completed mainly solely by members of the team with an excellent fraction of publications received during collaboration on both, national and international level.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Excellent number of students participated on research of the department during the evaluated period. They were supervised or co-supervised by members of the department. 7 bachelor, 10 master and 13 Ph.D. students were involved into the work of the department.

Particular contributions of students to research

Students participated directly on the research mostly related to the research performed by the supervisor or co-supervisor, or they have performed experimental research in laboratories of the department. 2 French students spent 4-months stays within the frame of ERASMUS project.

Number of defended PhD students in relation to students involved (success rate)

13 Ph.D. students were involved into the research of the department, 4 theses were already defended, 9 students still work on their theses.

Employment of former PhD students (career options)

Several students that have been partially employed in the department during their studies are now members of the research team.

5.3 Declaration on societal relevance

Impacts of the results and other activities on education

The Department D4 collaborates on education of graduate and postgraduate students in cooperation with the Czech Technical University in Prague [CTU] (Faculty of Mechanical Engineering [FME,CTU], Faculty of Nuclear Sciences and Physical Engineering [FNSPE,CTU], Faculty of Civil Engineering [FCE, CTU], Faculty of Electrical Engineering [FEE,CTU]), the University of West Bohemia in Pilsen (Faculty of Applied Sciences [FAS, ZCU], Faculty of Mechanical Engineering [FME, ZCU]), the Technical University of Liberec [TUL], the Technical University of Ostrava [TUO] and the Jan Evangelista Purkyně University in Ústí nad Labem [JEP] and the Uppsala University, Sweden [UU]. The pedagogical activity is exclusively based on exclusive possibilities of individual department members depending on their personal relations with the university departments under individual contracts or part-time jobs.

LNDT laboratory organized in 2010, 2013, and 2014 three NDT certification courses and exams of "Acoustic emission Level II" for Association for Personal Certification (APC). In 2013 and 2014 LNDT laboratory organized two educational courses for secondary school teachers of biology, chemistry, and physics "Open Science III" with theme "Ultrasonic methods for investigation of human skin".

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

Members of the department work actively in scientific boards of conferences and colloquia, they are members of scientific committees and panels of CSF, TACR, ESF, NCSF-National Council for Scientific Research-Romania, etc. Zdeněk Převorovský is actively working as vice-president of the Czech Society for Nondestructive Testing (CNDT), which is member of European Federation for NDT (EFNDT) and world organization on NDT (ICNDT). Miloslav Okrouhlík is the chairman of CSM, Dušan Gabriel is the chairman of experts group Computational mechanics. Members of the department worked as editors or in editorial boards and as reviewers.

Popularisation and similar activities

Every autumn the Institute of Thermomechanics opens its gates to the general public and welcomes its visitors with a range of exciting lectures, short excursions to its laboratories, and interactive and hands-on experiments. The Open Days were held in the laboratories of Department D4 in Prague and Pilsen, in 2010-2014.

“Digitally interactive” poster presenting a selection of research exhibits of "Cracks in aircraft structure" in the Academia bookstore in Prague during the month of May 2013. The presentation was supported by an internet campaign (on the Institute’s web portal). Institute of Thermomechanics promotion panel at the exhibition part of 11th European conference on NDT (ECNDT 2014) in the Congress Centre of Prague. Zdeněk Převorovský: Interview for "Anticorrosion protection" (Russian Industrial Portal - O-Journal 3/2011).

Numerous popularization lectures. Publication for science promotion.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The outputs of the department belongs to world leading and internationally excellent ones published in journals with excellent reputation. There are no citation from the first decile, however numerous citations from the first quartile.

Role and position in international collaboration

Members of the team have a broad collaboration with internationally recognized laboratories in University of Colorado at Boulder, USA; Korea Atomic Energy Research Institute, Republic of Korea; Institute of Cybernetics at Tallinn University of Technology, Estonia, University of Maribor, Slovenia; Northern Arizona University, USA; University of California at Davis, USA; University of California at Santa Barbara, USA; University of Colorado at Denver, USA; Viterbi, University of Southern California, USA; INSA Val de Loire, Blois / University Francois Rabelaise in Tour (F), FEMTO Institute / Université de Franche-Comté, Besançon (F); etc. The research is often done within the frame of collaborative projects.

Breadth/completeness of the research activities compared to world leading teams of comparable size

In comparison with world leading teams the coverage of studied topics is really broad but logical consequence of the composition of the department and the whole institute.

Ability to attract foreign researchers at different levels

This ability is limited by the amount of money offered to foreign researchers, which is very low in comparison with salaries in developed countries.

Position of the team in the national context

The team belongs together with collaborating universities to leading in the field. It is recognized by large number of projects funded by CSF, TACR and directly by contractual work.

5.5 Declaration on the vitality and sustainability

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

The age structure of the team is not of very uniform distribution, nevertheless the team has promising number of younger researchers, including students, young researchers, post docs, research fellows and senior researchers with the best qualifications reachable in the Czech Republic, which was further improved by a direct collaboration or long-term stays in foreign institutes. Nevertheless, the structure suffers from a lack of directly employed foreign researchers and Ph.D. students. Also the number of female researchers is rather low. This fact is however, a reflection of general situation in natural and technical sciences.

Attraction of research programmes for young people

The department uses a balanced combination of theoretical, modelling and experimental techniques and their attraction to young people is reflected by a large number of students doing their theses directly at the department.

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

Very good additional support originating from numerous projects funded by CFS, TACR, MEYS and contractual work. Larger support from international funds is limited.

Effectiveness of research (based on comparing size of groups, funding and output)

The quality of outputs is excellent, however the total number of contributions in highly ranked journals is not sufficient for a group of researchers of such a quality.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The involvement of young researchers confirms a proper choice of recruitment method. Lower number of female researchers and international researchers is a reflection of general Czech social conditions.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

The majority of research work performed in previous years will continue also in the next period. The strategy is based on supporting directions funded from external national resources and international collaboration, including contractual works. The main areas will be: Wave phenomena in solids: numerical, analytical and semi-analytical approaches; Modelling and verification of nonlinear material behaviour; Nano-identification of ductile-brittle behaviour in bcc iron; Acoustic emission (AE) source location and identification on remote complex and anisotropic structures; Nonlinear Elastic Wave Spectroscopy (NEWS) in structural health monitoring (SHM); Reconstruction of ultrasonic sources by means of Time Reversal Mirrors and In vivo mechanical and ultrasonic investigation of human skin.

Adequacy of available means and human resources to achieve these plans

The department has appropriate means and knowledge to achieve the planned results and the potential to receive sufficient support from external funds. However, a tendency of decreasing number of research workers might be a threat for future plans.

Missing issues in the strategy

It is not defined how to stabilize the number of research workers. Despite the international excellence of the department no strategy for receiving international funds is defined.

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No. 5: Dept. D5 Ultrasonic Methods

1. INTRODUCTION

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

The department consists of two laboratories - Laboratory of ultrasonic methods and Laboratory of experimental stress analysis, and is located in the main building of the Institute of Thermodynamics in Thermomechanics CAS, in Dolejškova 5, Prague 8.

1.2 Mission and research topics

Laboratory of ultrasonic methods deals with both experimental and theoretical research in the field of mechanics of materials. It is oriented on the utilisation of physical acoustic principles for the evaluation of mechanical properties of metals, intermetallics, ceramics, composites, and functional materials (ferroics) as well as the characterisation of structural changes and material damage. For this purpose the laboratory develops original ultrasonic methods such as resonant ultrasound spectroscopy, acousto-optical methods, etc.

Laboratory of Experimental Stress Analysis deals with transient phenomena associated with stress wave propagation in solids. These are typically generated by impact loadings delivered by air gun projectiles, exploding wires technique, by different types of impactors or by focused ruby laser beam. Both coherent optics (such as double-pulse holographic interferometry, electronic speckle interferometry or laser vibrometry) and dynamic responses measured by semiconductor strain gauges or accelerometers are used. The results are applicable to non-destructive defectoscopy, construction and the automobile and armament industries, as well as injury biomechanics and in criminal traceology.

1.3 Staff size and full time equivalents age distribution

The number of researchers is 10 with average aggregate FTE in the year 2014 9 and the number of other workers 7 with the average aggregate FTE in the year 2014 5.4. The department has 10 researchers below 35 years, 6 researchers below 50 years and 2 researchers above 65 years.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The main scope of the department covers internationally relevant topic of mechanics of materials and transient phenomena associated with acoustic wave propagation in solids.

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

The department had a moderate financial support from external sources, mainly from CAS, CSF and also EC.

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

Intensive collaboration within the institute, very good collaborative work with other institutes of the CAS, Czech universities and excellent long-term collaboration with international research institutes.

2.4 Position of the institute within the Czech scientific community and its international position

The department belongs to leading and nationally and internationally recognized laboratories with the access to European funds and financial support by the Centre of excellence.

2.5 The overall capacity of staff

The department has an increasing number of average aggregate FTE.

2.6 Comments on the age structure

Very good fraction of young researchers.

2.7 Frequency and quality of publications

Very good frequency of publications in high quality journals with more than 1 publication per year per one FTE of research worker.

3. WEAKNESSES AND THREATS

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

Limited support from contractual works and missing support from TACR. Orientation of majority of projects on support from CSF might be a threat for the department in the future.

3.2 The overall capacity of staff

The total capacity of the department is reasonable, however one laboratory has only two members which might be a threat for any future development.

3.3 Reasonability of the structure of the institute and the departments

The structure and division into laboratories reflects main streams of the research of the department, however the Laboratory of Experimental Stress Analysis reached the critical minimum size.

3.4 Comments on the age structure

Number of senior and junior members of staff is very well balanced but there is a total gap in the age period 50-65. This fact might result in some problems in the continuity of the research after the retirement of senior researchers after several years.

3.5 Patents and role in contractual work

No patents were received in the evaluated period, the support from the contractual work is rather low.

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

Consolidation and augmentation of the number of researchers of Laboratory of Experimental Stress Analysis or merging of the two existing laboratories.

4.2. Identification of new research topics

Attempts to find possibilities for a deeper collaboration with industrial partners with the vision for future collaboration within projects of TACR.

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 research works deal with both experimental and theoretical research in the field of mechanics of materials. The LUM laboratory is oriented on the utilization of physical acoustic principles for the evaluation of mechanical properties of advanced and functional materials. Main scopes are the determination of mechanical properties of advanced materials by ultrasonic methods, construction of the theoretical models on the underlying microstructural phenomena use of these models to explain the constitutive behaviour at the continuum level. For this purpose, the laboratory continuously develops original ultrasonic methods mainly based on laser-ultrasonic techniques (thermo-elastic generation of ultrasound in solids and laser detections of ultrasonic vibrations) such as contactless resonant ultrasound spectroscopy, bulk and surface acoustic wave methods, guided waves, etc. The laser-based ultrasonic

methods belong to key analytical instruments of the Advanced materials multidisciplinary research center (AdMat) supported as the Center of Excellence by Czech Science Foundation. Study of the Laboratory of experimental stress analysis deals with nondestructive characterization of defects in thin wall shells using acoustical wave propagation and dynamical behaviour and rheological properties of foodstuffs and selected agriculture products.

Relevance in the national and international context

The relevance of results is supported by numerous international collaborations and large number of national and two international projects including one Czech Centre of excellence. Results were published in world leading journals.

Overall quality of publications

Large portion of publications was published in the world leading journals or journals highly recognized by the scientific community. The impact on the scientific community measured by the number of citations from high ranked journals, however is not very high, nevertheless contains citations from the world leading journals from the first decile.

Specification of the main achievements

Main scientific outputs of the LUM team during the given period fall into following categories:

development of ultrasonic methods themselves, the use of these ultrasonic methods for characterization of advanced materials, the mathematical modeling of the constitutive behavior of studied materials, experimental and theoretical interpretation of non-stationary wave phenomena occurring in impacted thin-walled shells and mechanical responses of the selected agricultural products (fruits, cheeses and eggs) on impact loadings.

Specification of the contributions of the team to publications

The majority of evaluated publications was received within the frame of excellent collaboration between institutes of the Academy of Sciences, collaboration with other Czech and foreign institutes and universities.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

Excellent number of students participated on research of the department during the evaluated period. They were supervised or co-supervised by members of the department. 10 bachelor, 9 master and 5 Ph.D. students were involved into the work of the department.

Particular contributions of students to research

Students participated directly on the research mostly related to the research performed by the supervisor or co-supervisor, or they have performed experimental research in laboratories of the department.

Number of defended PhD students in relation to students involved (success rate)

Five Ph.D. students were supervised or co-supervised during the evaluation period. One thesis was defended.

Employment of former PhD students (career options)

The department provides excellent opportunity for employment of former students. Several students that have been partially employed or co-supervised in the department during their studies are now members of the research team.

5.3 Declaration on societal relevance

Impacts of the results and other activities on education

The department directly collaborates with Faculty of Nuclear Science and Physical Engineering, Faculty of Mechanical Engineering and Faculty of Electrical Engineering of Czech Technical University in Prague and Faculty of Mathematics and Physics of Charles University in Prague.

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

Members of the team participate on decisions of Acoustic Society of America, Committee for Ph.D. studies of Faculty of Mathematics and Physics and Faculty of Electrical Engineering. They have worked as members of the local organizing committee of a conference and editorial board of JMEP and referees of several journals.

Popularisation and similar activities

Short course Ultrasonic Characterization of Advanced Materials within IUS Tutorial lectures, Joint IEEE-International UFFC, EFTF and PFM Symposium, July 21-25, 2013, Prague, Czech Republic. Several invited lectures on workshops and at seminars in the Czech republic as well as in foreign institutes were given. Annual participation of members of the team on the Week of Science and Technology, participation on Open Science – promotion of research and development, short article in newspaper DENIK, interview for the Czech Radio Vltava, etc.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The outputs of the department belongs to world leading and internationally excellent ones published in journals with excellent reputation. Although the impact of selected publications is not too high, the citations come from high ranked journals from the first decile and quartile.

Role and position in international collaboration

Members of the team have a broad collaboration with internationally recognized laboratories. With the Institute of Ceramics and Glass (ICV-CSIC) in Madrid (Spain), Aalto University (Finland), Israeli Institute of Technology (Technion, Haifa), RWTH Aachen University Mathematical Institute of the Oxford University, Adaptamat Ltd. (Helsinki, Finland), IFW Dresden (Germany), LEMTA – ESSTIN, Université Henri Poincaré v Nancy (France) within a long-term international collaboration and bilateral projects. ICV CSIC Madrid)

Breadth/completeness of the research activities compared to world leading teams of comparable size

The research area of the Department covers a broad range of topics thanks to a broad national and international cooperation with leading institutes.

Ability to attract foreign researchers at different levels

This ability is limited by the amount of money offered to foreign researchers, which is very low in comparison with salaries in developed countries.

Position of the team in the national context

The team belongs together with collaborating universities to leading laboratories in the field. Large number of original techniques was developed in the Department.

5.5 Declaration on the vitality and sustainability

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

The age structure of the team suffers from the absence of researchers between 50-65 years. Nevertheless the team has promising number of younger researchers, including students, young researchers with qualifications reached at Czech universities, which was further

improved by a direct collaboration or long-term stays in foreign institutes. Nevertheless, the structure also suffers from a lack of directly employed foreign researchers and Ph.D. students. The number of female researchers is about 50%.

Attraction of research programmes for young people

Modern and original experimental and theoretical methods are very attractive for young researchers, which is supported by the fraction of young researchers in the team (more than 30% of researchers below 30 years) and the number of bachelor and master students directly involved into the research activities of the team.

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

Except for institutional funds, the majority of incomes originated from the major Czech foundation – CSF. The role of contractual works is minor, support from TACR is missing. The department had two European projects.

Effectiveness of research (based on comparing size of groups, funding and output)

The quality of outputs is excellent, the majority of evaluated outputs belong to world leading or internationally recognized group. The number of outputs during the evaluated periods is comparable with excellent laboratories in the world.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The involvement of young researchers and number of female researchers confirms a proper choice of recruitment method. The absence of foreign researchers is given by the amount of money offered to foreign researchers, which is very low in comparison with salaries in developed countries.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

All planned experimental and modelling activities follow from already well-established collaborations, and they are covered by the running projects and by topics of PhD, MSc and Bc students working currently under supervision or co-supervision of members of the team. In addition, new topics can be expected to arise from recently initiated collaborations with several foreign research and industrial partners: Clemson University (South Carolina, US), Tohoku University (Japan), TÜV Rheinland Group (Oosterhout, Netherlands) and Rafael Advanced Defense System (Haifa, Israel). Detailed description of the future individual

research topics of the LUM laboratory is given in evaluation materials. The research of the second laboratory will be mainly focused on the frequency dependence of the attenuation, phase velocity and Poisson's ratio in various types of polymeric materials.

Adequacy of available means and human resources to achieve these plans

The department has appropriate means and knowledge to achieve planned results and the potential to receive sufficient support from external funds including European funding. However, the number of researchers of the Laboratory of Experimental Stress Analysis has reached a critical size and might be a reason for limitations of research of this team and the ability of this group to receive a reasonable support from external resources.

Missing issues in the strategy

Detailed description of future plans for next five years of the Laboratory of Experimental Stress Analysis is limited only to a short paragraph, which is a probable reflection of a low number of researchers of this laboratory, indicating a gradual reduction of the activity of the laboratory.

EVALUATION OF THE INSTITUTE OF THERMOMECHANICS

Team No. 6: Dept. D6 Electrical Engineering and Electrophysics

1. INTRODUCTION

[1] Location of the institute and its dept., labs. & sub units.

The department consists of four principal laboratories - Dynamics of Electrical Machines and Drives, Power Electronics, Coupled Problems in Electrical Engineering and Electrophysics. Laboratories are located in the main building of the Institute of Thermomechanics of CAS, in Dolejškova 5, Prague 8.

1.2 Mission and research topics

Main topics are theoretical and experimental research of electromechanical conversions; analysis, modelling, and control of electric drives, rotating machines, and variable-speed electric generators for utilization of renewable energy sources; analysis and diagnostics of power and control circuit structures for solid-state power converters and their digital control algorithms; research of interaction of electronic power converters with electric machines and power grid. Experimental investigations dealing with dynamics of electric arcs and jets of high temperature gas (thermal plasma), nonstandard numerical methods for solving electromagnetic fields and algorithms for solving coupled problems in heavy-current electrical engineering and electrical power engineering.

1.3 Staff size and full time equivalents age distribution

The number of researchers is 14 with average aggregate FTE in the year 2014 8.3 and the number of other workers is 17 with the average aggregate FTE in the year 2014 5. The age structure of the department is characterized by a large fraction of senior researchers above 60 years (16).

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The department deals with a world leading and internationally recognized research. The current challenges of power engineering, such as the power quality and the stability of the power grid with a large ratio of renewable energy sources, impose new demands on the research in electrical engineering. At present, the research is influenced to a great extent also by the current progress in the field of electromobility. There are also a number of emerging industrial applications, particularly in induction heating, plasma spraying, plasma cutting or plasma chemistry, where the achieved results can be effectively utilized.

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

The department received very good financial support from external resources. The research at the Department is mostly done in the framework of research grant projects and in co-operation with industrial partners. During the evaluation period the researchers of the Department participated in research grant projects funded by the Czech Science Foundation, Grant Agency of the Czech Academy of Sciences and by the Grant Agency of the Ministry of Industry and Trade of the Czech Republic. The research for practice was done in the framework of 4 contractual research projects and 6 collaborative research projects.

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

Members of the research team have excellent intensive contacts with a number of renowned research institutions abroad. There is effective collaboration with universities and research institutions involved in similar research areas. For example with the Institute for Drive Systems and Power Electronics, Leibniz University Hannover, Germany; the University of Wisconsin-Madison, USA; the Faculty of Electrical Engineering, Czech Technical University in Prague; the Faculty of Electrical Engineering, the University of West Bohemia in Pilsen; or the Faculty of Electrical Engineering and Communication, Brno University of Technology.

2.4 Position of the institute within the Czech scientific community and its international position

The department together with similar institutes at universities belongs to a leading institution in the field in the Czech Republic with excellent international recognition and collaboration. Members of the research team participated in several research exchange visits at foreign universities and the department hosted several visiting researchers from other research institutions and universities. The department is a Competence Center of the European Center for Power Electronics.

2.5 The overall capacity of staff

The capacity of the research team is in accordance with needs of main research activities.

2.6 Reasonability of the structure of the institute and the departments

The division of the department into four parts very well reflects main research activities.

2.7 Frequency and quality of publications

Very good frequency of publications in high quality journals with more than 1 publication per year per one FTE of research worker. Several publications belong to world leading and internationally recognized ones.

2.8 Patents and role in contractual work

Contractual work is a significant source of external incomes.

3. WEAKNESSES AND THREATS

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

Financial support from international funds is missing.

3.2 Comments on the age structure

The age structure of the department is a cardinal problem. The majority of the scientific team is above the age of 60 years

3.3 Patents and role in contractual work

No patents were received during the evaluated period.

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

Reorganization of the department does not solve the problem with the age distribution of the department. Focus on attraction of researchers from other institutes or researchers from abroad may help.

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

Strengthening of existing international collaboration resulting in joint international projects is strongly recommended.

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)

Research activity of the department are of both - theoretical and experimental character. Activities reflects the division of the department into four laboratories. Laboratory of Dynamics of Electrical Machines and Drives is engaged in the analysis and modelling of electric drives and rotating machines along with experimental verification of the achieved results. The most important methods for the conversion of mechanical energy into electrical energy and vice versa are analysed. Considerable attention has been given to systems with doubly fed machines, which can operate at variable speed and thus seem to be promising

generators for wind and hydro power plants. Another goal is to propose effective measures for keeping the drive in operation even if some of its components fail. Laboratory of Power Electronics is focused on current problems connected with the circuit structures of power electronic converters and algorithms for their control and diagnostics. The mutual effects of converters with the machines that are fed from them and the supply networks they are connected to are analysed. Advanced control algorithms of AC drives and multilevel frequency converters are developed and tested experimentally. The ways for avoiding the unfavourable high-frequency phenomena (electromagnetic interference) produced by solid-state converters are studied. Laboratory of Coupled Problems in Electrical Engineering developed advanced versions of numerical methods for the solution to physical fields. These are primarily higher-order finite element methods with automatic adaptivity, supplemented with technologies of hanging nodes and independent discretization meshes for individual physical fields as well as some integral methods. These methods are then applied to the solution to selected coupled problems in the area of electrical power engineering, electromagnetic compatibility and in several other technical problems. Laboratory of Electrophysics is focused on dynamic phenomena and coherent structures in electrical arcs and in thermal plasma plumes including the interaction of these structures with injected particulate matter.

Relevance in the national and international context

During the evaluated period unique data were received. Results often belongs to world leading or internationally recognized ones. This fact is supported by numerous research projects and collaborations with the industry. During the evaluation period the researchers of the Department participated in 7 research grant projects funded by the Czech Science Foundation, in 3 research grant projects funded by the Grant Agency of the Czech Academy of Sciences, and in 2 research grant projects funded by the Grant Agency of the Ministry of Industry and Trade of the Czech Republic. Researchers published 47 articles in journals with the Impact Factor. The results of the applied research have been protected by 8 Functional Models or Utility Models issued by the Patent Office of the Czech Republic. The people from the department also participated in research projects carried out in other departments of the Institute, where they offer their knowledge and competencies in the field of electrical engineering and electronics.

Overall quality of publications

The number of publications in journals with IF is 47. Large portion of publications was published in the world leading journals or journals highly recognized by the scientific community. The department has several citations from highest ranked journals from the first decile. Large collaboration outputs are missing.

Specification of the main achievements

Among main research activities belong experimental and theoretical research of reliability and failure tolerance of AC variable-speed drives, minimizing DC-link voltage variations in voltage source inverters, control of multi-phase electric machines, new space vector modulation strategies and analytical solution to current responses for grid connected four-switch converter and hybrid power filter, modern power theories and compensation algorithms, development of medium-voltage flying-capacitor converter, development of control systems for medium-voltage industrial applications, algorithms for fully adaptive higher-order finite element method intended for numerical solutions to evolutionary multiphysics problems, temperature measurements in non-stationary thermal plasma and influence of plasma instabilities, new methods for time-series analysis, applied to unstable thermal plasma, and diagnostics and development of plasma cutting torches.

Specification of the contributions of the team to publications

A majority of evaluated outputs was received solely by the members of the department. Several contributions were submitted as a result of a collaboration between members of the team and other institutes of CAS and industrial partners in the Czech Republic and abroad.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

During the evaluated period 1 master and 5 doctoral students participated on the research activities of the department.

Number of defended PhD students in relation to students involved (success rate)

Two doctoral theses were defended during the evaluated period.

Employment of former PhD students (career options)

Two former students are employed at the department at postdoc positions. Two other students are expected to finish their studies and become members of the team.

5.3 Declaration on societal relevance

Impacts of the results and other activities on education

The members of the Department regularly teach at two Czech universities in bachelor, master and doctoral programs (Faculty of Electrical Engineering, Czech Technical University in Prague, Faculty of Electrical Engineering, University of West Bohemia in Pilsen), usually in the framework of part-time employment agreements.

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

Members of the team actively participate on decisions of several commissions and panels. Namely in Field Verification and Evaluation Panel in the domain of Technical Sciences and Informatics (advisory panel of the Council for Research, Development and Innovation of the Czech Republic), Expert Panel in the domain of Technical Sciences and Informatics (advisory panel of the Council for Research, Development and Innovation of the Czech Republic), Evaluation Panel (Electrical Engineering and Electronics) of the Czech Science Foundation, Scientific Board of the Faculty of Electrical Engineering, University of West Bohemia in Pilsen, Scientific Board of the University of West Bohemia in Pilsen, Scientific Board of Jan Perner Transport Faculty, University Pardubice, Scientific Board of RICE - Regional Innovation Centre for Electrical Engineering, Pilsen, Committee of Electrical Drives of the Czech Society of Electrical Engineering, IAS/IES Chapter Czechoslovakia Section IEEE, IET Czech Republic Network Scientific Board of the Faculty, Editorial Board of Acta Technica CSAV, EC programs FP7: PEOPLE, INFRASTRUCTURES, ENERGY, etc. They also prepared numerous reviews of scientific publications.

Popularisation and similar activities

The Department regularly participates in the Doors Open Days of the Institute. There was also a visit of high-school teachers to the laboratories of the Department in 2014 organized in co-operation with the CEZ Group accompanied by practical presentations and lectures.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams

The quality profile of the team is of very high range with two evaluated results belonging to world-leading ones. Several publications comes from highly ranked journals from the first decile or quartile. From this point of view the institute is comparable with institutes in Europe. Nevertheless, the impact of their work quantified by the number of citations from world leading journals from the first decile is limited to 3 and from the first quartile to 2.

Role and position in international collaboration

International collaboration is an integral part of research activities of the team. The members of the research team have extensive contacts with a number of renowned research institutions abroad. There is effective collaboration with universities and research institutions involved in similar research areas, e.g. with the Institute for Drive Systems and Power Electronics, Leibniz University Hannover, Germany; the University of Wisconsin-Madison, USA; The Department has been co-organizing international symposia with the above mentioned Institute for Drive Systems and Power Electronics at Hannover since 1988. Members of the research

team participated in several research exchange visits at foreign universities and the Department hosted several visiting researchers from other research institutions and universities. The Department is a Competence Center of the European Center for Power Electronics.

Breadth/completeness of the research activities compared to world leading teams of comparable size

The breadth of research activities is documented by a high number of scientific outputs, which were often received within the frame of projects supported by Czech Science Foundation or within the collaboration with industrial partners. The division of research activities reflects the composition of the research team and from this point of view is comparable with activities for example of the above mentioned Institute for Drive Systems and Power Electronics, Leibniz University Hannover.

Ability to attract foreign researchers at different levels

Incomparable financial conditions of the institute in the international scale limits significantly the possibility to attract foreign researchers including Ph.D. students from developed countries.

Position of the team in the national context

The team belongs to leading group at the national level with established collaborations with several Czech teams.

5.5 Declaration on the vitality and sustainability

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

The age structure of the Department is far from ideal.

A significant lack of researchers of a middle age and a high number of researchers above 60 years might result in a significant reduction of research activities in next years. Several members of the team have an international experience from long-term stays abroad. But in average this experience is not declared for large number of the team. The structure also suffers from a lack of directly employed foreign researchers and Ph.D. students. The number of female researchers is very low (three are declared).

Attraction of research programmes for young people

The department possess original experimental and theoretical methods, which should be attractive for young researchers. However, this is not reflected by the number of students,

especially students of bachelor and master programs. On the other hand, the department is able to form sufficiently attractive conditions in order to employ their former Ph.D. students.

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

Direct role of contractual research is rather limited, incomes from collaborative research with the industry provided nearly 86 thousands EUR. The majority of external funding originated from the Czech Science Foundation and projects of the MIT. Although the team possess a broad international collaboration any funding from external foreign resources is missing.

Effectiveness of research (based on comparing size of groups, funding and output)

The number of high-ranked publications corresponds well with the financial support from projects.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The involvement of young researchers confirms an improved choice of recruitment method in the evaluated period, which may partially suppress the unpleasant situation from previous periods. Lower number of female researchers and international researchers is a reflection of general Czech social conditions.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

In the coming years, the team will continue with the previous research, nevertheless, new directions usually connected with submitted research projects or collaborations with the industry and foreign laboratories are planned. The preferential topics will be the problematics of induction machines with combined star-delta windings, advanced three-phase synchronization techniques for grid-connected converters, grid interfacing electronic power converters, algorithms for fully adaptive higher-order finite element method, and investigation of non-stationary thermal plasma at multiple temporal and spatial scales. These planned works show growing interest from both theoretical and also industrial use point of view.

Adequacy of available means and human resources to achieve these plans

Although several new topics appear in future plans their coverage by appropriate projects is rather disputable. Only one project with reasonable budget was submitted to Czech Science foundation. The second one is within the frame of KONTAKT projects with only a limited

support for cooperation. Also the personal capacity taking into account the age structure of the department might be not sufficient.

Missing issues in the strategy

Deeper analysis of possibilities how to attract new researchers and to overcome unpleasant age structure and decreasing number of average FTE is not specified.

Date: January 20, 2016

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