Evaluation of research and professional activity of research-oriented institutes of the Czech Academy of Sciences for the period 2015–2019

Final Report

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

Evaluated teams and their leaders:

1. D1 – Fluid Dynamics (Martin Luxa)
2. D2 – Thermodynamics (Jan Hrubý)
3. D3 – Dynamics and Vibration (Luděk Pešek)
4. D4 – Impacts and Waves in Solids and Centre CeNDYNMAT (Dušan Gabriel)
5. D5 – Ultrasonic Methods (Hanuš Seiner)
6. D6 – Electrical Engineering and Electrophysics (Miroslav Chomát)

Part A: Evaluation of the institute

Introduction

The Institute of Thermomechanics of the CAS, founded in 1953 as the Laboratory of Mechanical Engineering, belongs to the backbone of the higher education of the Czech Republic in the field of engineering and physics. IT acts as a co-guarantor of six doctoral programs and runs three joint research centres as well as four joined laboratories in cooperation the universities. The institute library serves as a core public library with specialized library stock.

Traditionally rooted in the field of mechanical and the power engineering, the institute today preserves and advances the art of engineering alike. The IT maintains highest-quality research infrastructure, information technology and computational resources. Additionally, there exists remarkable know-how in the institute's workshops, adding practical competence to design and maintenance of specified laboratory devices.

The finance of IT is based to 60% of direct institutional funding. 35% of the budget originates from competitive grant funding, tendered by the Czech Republic, with a single exception of EU-funding. 5% of the budget originates from contracted work revenues [A2]. The respective shares of the teams D1-D6 of the third party funding are shown in the figure below.

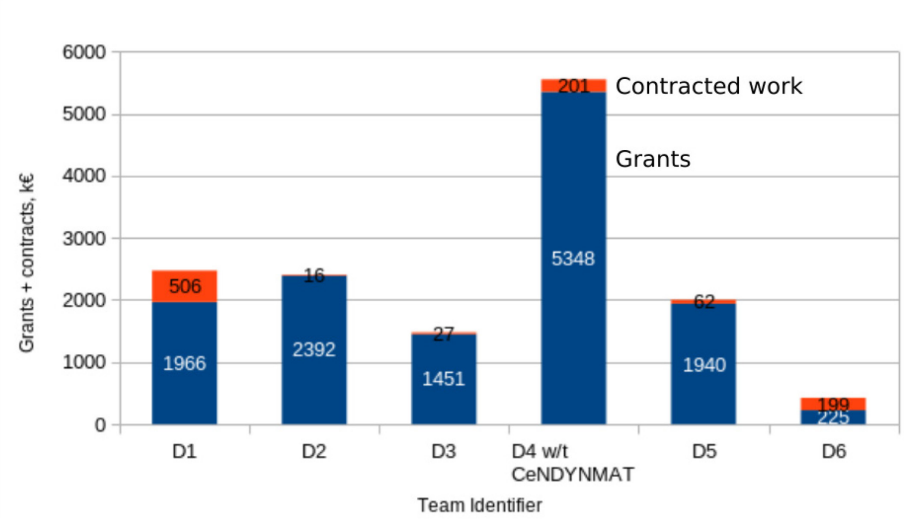


Figure: Accumulated third-party funds per team during the evaluation period in k€ [A3]

An international advisory board (IAB) was established in the year 2018. It consists of seven excellent scientists from four countries (GER, POL, ISR, USA), six of them being affiliated with academic research institutions. Under the lead of Prof. Roland Span (Ruhr-Universität Bochum, Germany) the IAB has launched consultative work and already provided a feedback document that was made available to the evaluation commission. In the document, three central challenges for a positive development of the IT are enumerated: (1) the age structure of the institute, (2) improvement of the cooperation between the individual teams and (3) the development of a scientific focal points and an organizational structure that allows for leading roles in large European projects, including the role of the project coordinator.

The evaluation commission appreciates the thorough work of the IAB and agrees largely with their feedback. An additional fourth challenge may be added: (4) the provided figures indicate there is room for improving the knowledge transfer from IT to the practice, and also to improve the profitability of the contracted work.

Strengths:

- Strong ties with universities – nationally and internationally.
- Full and seamless integration into the international research community.
- Large variety of technical topics concerning mechanical, material or electrical engineering.
- Operation of unique and excellent experiments
- In most of the studied problems, the experimental research is closely connected with the theoretical research.
- High publication scores in renowned journals in the fields of mechanical and material engineering, thermodynamics, electrical engineering and electrophysics.
- Strong practical know-how in laboratories and workshops.

Weaknesses:

- Granularity of contracted work. Missing patents.
- High diversification of the research.
- Salaries in the institute are slightly below the average of the CAS and of the major Czech universities. PhD students have only part-time contracts (typically 20% (!!) in the beginning of their studies).
- Limited participation in EU and other international projects.

Opportunities:

- Improvement of the HR development strategy, including a policy to improve the gender balance and unattractive salaries for young scientist, as well as the development of an international recruitment strategy.
- Sharpening of the scientific scope. Especially improvement of the interaction of team D6 with the remainder institute.
- Improvement of the profitability of contracted work

Threats:

- Age structure of the research teams in several teams.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
Quality levels (QL) have been specified by CAS as follows:	
QL 3:	Quality that is recognized internationally in terms of originality, significance and rigour and/or result of recognisable novelty with actual or likely future innovative potential.
QL 2:	Quality is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence and/or highly sophisticated result with actual or likely future significant innovative potential.
QL 1:	Quality is world-leading in terms of originality, scientific significance and rigour and/or with actual or likely future groundbreaking innovative potential.
The figure below provides a comprehensive view of the quality ratings achieved by the IT during phase I of the evaluation procedure on the background of all CAS teams visited by this commission (blue dots) [A5].	

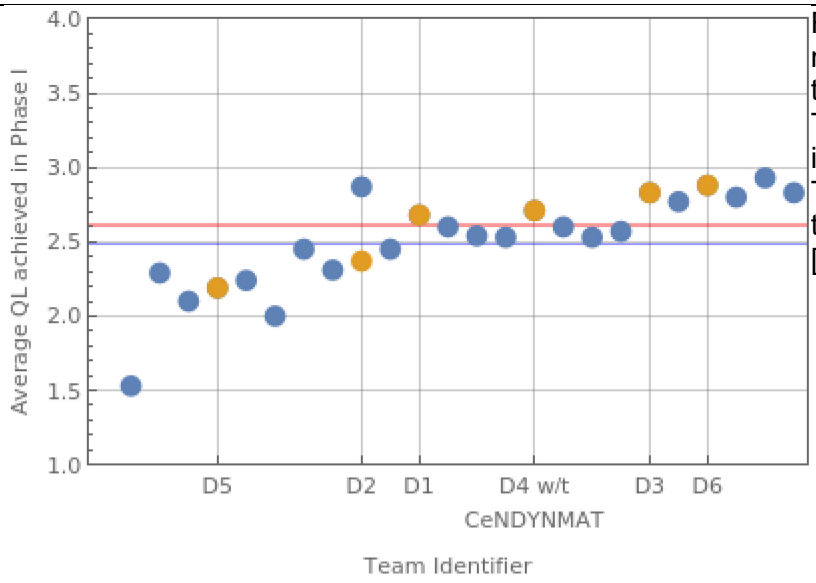


Figure: Individual average ratings of phase I for the six teams of IT (orange dots) o The mean rating of IT as institute is 2.61 (red line). The mean value of all visited teams is 2.49 (blue line). [A5].

The IT as institute achieved a mean ranking of 2.61. The teams D1, D3, D4 and D6 group close above this mean value. Hence their outputs fall into the category of QL 3(+) on average: recognized internationally and appreciated as of recognizable novelty, with actual or likely future innovative potential.

The outputs of team D2 and D5 are rated better, by 2.37 and 2.19 respectively, which justifies to attribute these teams to QL 2(-): highest standards of excellence and likely future significant innovative potential. The commission appreciates this result and remarks that team D5 was the smallest and youngest one of IT.

The rating of IT as institute (2.61) is slightly below (in terms of quality) the mean value of all outputs (2.49) in the pool of the evaluation commission 7.1. The reason for this remains unclear; in view of the intellectual potential and the fine laboratory equipment a better performance should be possible on average.

It may be noted that a team ranking based on the total number of outputs per team does not coincide with the ranking based on phase I ratings: The highest and next highest “paper productivity” was due to teams D3 (225 outputs) and D1 (201 outputs), respectively. This is an indication that the publication strategy might benefit from an adjustment from quantity towards quality.

H1.2	Contribution of workers on the outputs reached

To rationalize the contribution of workers to the outputs submitted to phase I, the mean fractional count FC/N may be used, where FC=A/B is the fractional count of the number A of IT authors and the total number B of all authors of all submitted outputs per team, and N is the number of outputs submitted by the team. So for example a value FC/N=0.5 meant that on team-average, half of the authors was affiliated with the team. The distribution of this fractional measure over the six IT teams is shown in the figure below.

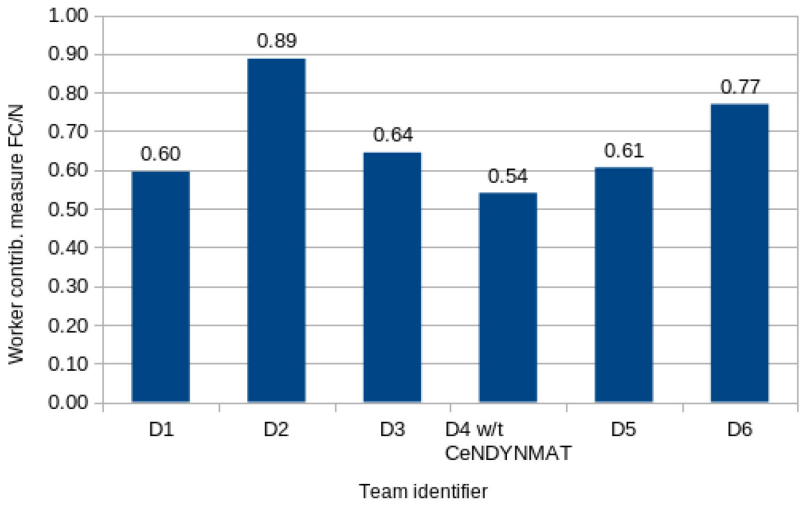


Figure: contribution of IT researchers to the outputs evaluated during phase 1 on average, based on [A5].

The mean value of all six numbers is 0.67, which means that at mean, outputs were produced by IT employees to a fraction of two thirds. The highest fractional value is achieved by team D2 (0.89), which means that the respective results were almost entirely produced by this team. This achievement may be assessed in combination with the average rating of team D2 (2.37), see section H1.1 above, to see that the high quality of D2 outputs essentially originates from the team itself. The lowest fractional value is due to team D4 (0.54), what is slightly astonishing in view of the human resources present in this team, cf. figure in section D2.7.

H1.3	Quality of all outputs and results

The documents [A4] list a total of 900 publications during the evaluation period. These were not reviewed during phase II in detail. Therefore, no comment can be given on quality regarding all these outputs.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

Today, the thematic focus of the institute is laid in the scientific fields of solid- and fluid-state mechanics / thermodynamics, being the topic of five out of the six teams (D1 to D5). These five teams also contributed 25 out of 26 outputs declared as „main research results“ of IT in document [A2], see figure below.

Team D5 contributed over-proportionally (by 35%) to these main research results of the institute, followed by team D2 (31%). Outputs of the team D5 also produced the best quality rating during phase I of the evaluation procedure, cf. section H1.1, again followed by team D2. These are clear indications that the “most valuable discoveries&findings” of the institute are due to the work of the teams D5 and D2.

The following main research results are appreciated by the commission:

- Power control of grid-connected converters under unbalanced voltage conditions (by team D6)
- Dynamics of the flow-field in the vicinity of vibrating airfoil NACA 0012 (D1)
- Determination of elastic moduli of thin micro- and nanostructured layers (D5)
- Numerical models of inelastic processes in shape memory alloys (D5)
- Model for gas hydrates relevant to CCS technologies (D2)
- Wave motion in a thick cylindrical rod undergoing longitudinal impact (D4)
- Impact of roof height non-uniformity on pollutant transport between a street canyon and intersections. (D1)

- Optimization of fluid jet actuators (D2)
- Elastic properties of magnetic shape memory alloys (D5)
- Implosive magneto-cumulative generator (D2)
- Methods and facilities for calibration of non-contact vibration diagnostics systems of machine blades (D3)
- Calibration of a simple directional distortional hardening model for metal plasticity (D4)
- Model of short-term gas release by industrial accidents for an idealized urban canopy (D1)
- Ultrasound characterization of growth of omega-phase nanoparticles in single crystals of titanium alloys (D5)
- Crack growth in Fe-Si single crystals on macroscopic and atomistic level (D5)

The respective results have been published in high-ranked journals and they were acknowledged by the evaluators during phase I of the evaluation procedure. Therefore, they must be regarded as finest and most valuable scientific results, which advance the present knowledge of their specific fields significantly.

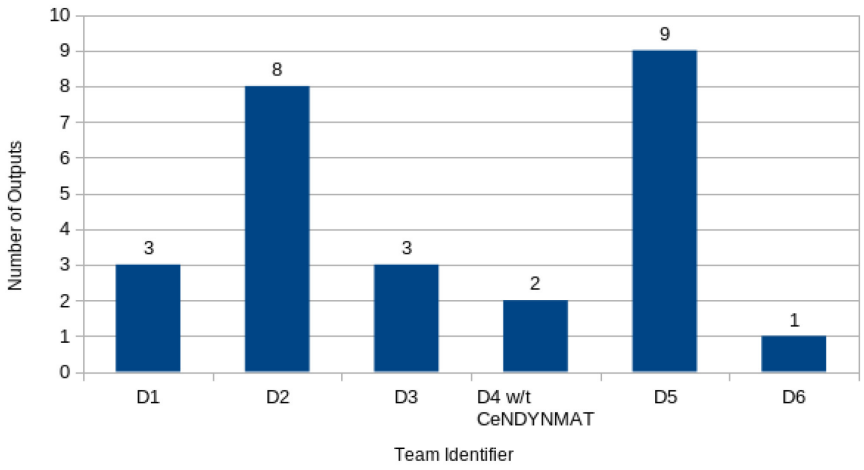


Figure: Contribution of IT teams to the institute's “main research results” according to [A2].

H1.5	Contribution of the participation of the authors in large collaborations

The commission interprets projects with three or more partners as “large collaborations” and identified the following ones [A2], [A6]

- Numerical models of inelastic processes in shape memory alloys: Long-term collaboration with the Institute of Physics CAS, RWTH Aachen (Germany) and ESRF Grenoble (France).
- Three workpages within the National Centre for Energy, the Technology Agency of the Czech Republic project no. TN01000007 which associates 23 research institutes, universities and companies
- Active research participation in the International Association for the Properties of Water and Steam (IAPWS).
- EU H2020 "Batista - Blade Tip Timing System Validator", ID 862034, Call Clean Sky 2. Partners: EMTD (Coordinator – GB), the University of Manchester (GB), SAB (Safran Aero Boosters – BE)
- Participation in two National Competence Centres of the Technology Agency of the Czech Republic (TACR),
- Participation in the project “National Competence Centre - Cybernetics and Artificial Intelligence”

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The term “relevance” is ambiguous. The institute serves important contributions to the higher education of engineers in the Czech Republic (see Sections D3.1-D3.6). Traditionally rooted in the field of mechanical and the power engineering, the institute today preserves and advances the art of engineering alike. The fields of activity (fluid/solid mechanics, thermodynamics and electrical engineering) belong to the fundamental core subjects of engineering, essential for both preservation and progress of the technological systems driven by a developed industrial society like the Czech Republic. In these regards, the work of IT is certainly highly relevant to the society.

A comment on the “mission”: The respective section of document [A2] appears as a retrospective, rather than a future mission. Hence, the institute seems to derive its future mission from tradition, while the concept in regard to present day challenges, like greenhouse gas mitigation, secure supplies of clean air, water and food, digital revolution, space exploration, high-tech warfare — to name some relevant examples, — remains slightly vague. This – on entry -evoked a quite rusty impression of the institute.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the institute´s activity on proper practice in society in the area of social sciences and humanities

See section H.2.3

H2.3	Relation to practice

IT refers to a close collaboration with eight private enterprises. Most of the applied research is related to the energy industry, characterization of material properties, and structure analysis. The outputs are usually directly related to the actual application. The results are typically described in the form of technical and research reports [A2].

There is remarkable application potential present in IT and some long-term collaboration with a number of industrial enterprises can be named: Škoda-Doosan Power, Bonatrans Group, Wikov. The best-known trademarks of IT are the vibrodiagnostic system of rotated bladed wheels in turbomachines, the methods of measurements of high-speed flow in blade cascades serving for optimization of 1000 MW turbines and a general-purpose in-house developed finite-element code PMD (Package for Machine Design) also used for the development of new original algorithms for numerical solution of specific problems of mechanical and material engineering.

During the evaluation period 2015-2019, a total of 68 contracted works have been conducted, which yielded a total revenue of 1035 k€. The majority of contracted work (40 out of 68) were relatively small projects, which produced revenues up to 10 k€ only, while larger projects were rare, see histogram below. The largest contracted work produced a revenue of 98 k€. This indicates a preference for “University-scale” contracts.

The profitability of the contracted work remains questionable. For example, a 7-month contract for the development and manufacturing of sensors returned a revenue of 2k€ only in 2018 [A3]. This specific example raises concerns, if the engineering service has been offered at market conditions (full cost balance), which is a general required to prevent (public-funded) market distortion. But also from the viewpoint of strategic project development it seems more effective to force the incubation of larger projects and longer-

term industry R&D cooperation. The histogram above reflects a different approach towards industry partnership. This observation is accompanied by the fact that no patents have been licensed during the evaluation period (as of documents [A4])

From interviews with other institutes in the evaluation pool, this commission learned that long-term projects are a necessary ingredient for successful patenting, which is then driven by the commercial partners. To just “enshrine a Council for Commercialization” [A2] proved ineffective. The commission therefore suggests to improve the exchange with the industry, for example by increase of the number of industry representative in the international advisory board and/or the attendance of applied industry exhibitions like Hannover Messe etc. IT has a lot knowledge to offer indeed.

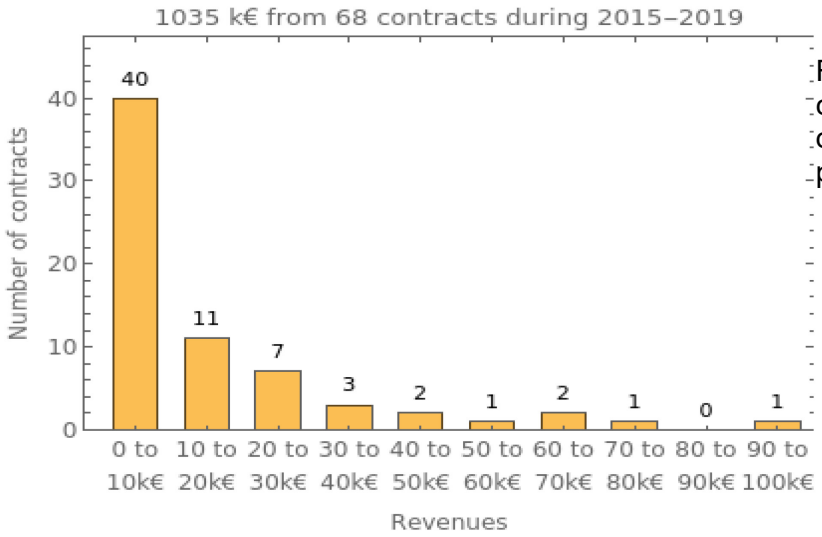


Figure: Histogram of contracted work projects during the evaluation period. Based on [A3].

H2.4	Participation in AV21 strategy

The participation of the IT in Strategy AV21 includes coordinating one of its research programs and participating into two others [A2]:

- Coordinating the research program „Efficient Energy Conversion and Storage“ (since 2015):
  The program is organized as a set of coordinated sub-programs (also “topics”) fostering interdisciplinary collaboration of 10 research institutes of the Czech Academy of Sciences and roughly 20 external collaborating entities. The research topics include efficient utilization of renewable energy sources and smart energy distribution, efficient and clean methods for processing fuels, nanostructured materials for energy conversion and storage, flywheel and thermal energy storage, and enhancement of power plant efficiency.
- Participation in the research program „Light at the Service of the Society“ (since 2017)
  Participation in the sub-program „Improving the resistance of materials“ coordinated by the Institute of Physics.
- Participation in the research program „Space for the Mankind“ (since 2019)
  Under coordination of Astronomical Institute: Measurements and modelling of vibrations and heat conduction in service modules of space vehicles.

H2.5	Cooperation with regions of the Czech Republic

The following cooperations with Czech regions are reported [A2]:

With the Central Bohemia Region, through collaboration with the Nuclear Research Institute Řež (ÚJV) and the Research Centre Řež (CVŘ). The Institute participated in the solution of several projects for the governmental institutions.

Through participation in projects with governmental institutions: Three projects from the State Office for Nuclear Safety (SÚJB), in the frame of the TAČR project NEMENUS. Research for SÚJB is motivated by an extension of the safe lifetime of Czech nuclear power plants. The related region is not named.

Experimental study for the National Institute for Nuclear, Chemical and Biological Protection focused on spread of pollutants in areas outside of the open terrain. The related region is not named.

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the teams and the institute with similar international and national institutes

This request is hard to answer, because of largely different economical situations in different countries. Since IT belongs to the Czech national academy of science, the comparison had to be drawn nationally funded research institutions like Institutes of the Max Planck Society (fundamental research), the Helmholtz Association (big science) or Fraunhofer Gesellschaft (applied research) in Germany, for example, which together received an annual budget of 9.4 billion € in 2019, however. Therefore, a direct comparison with such institutions is unfair. All despite this, the IT is able to coin its own scientific footprint in the European research landscape, mainly due to decent, homegrown expertise, sometimes even at world-leading excellence, especially in the fundamental academic sciences, see for example teams D2 or D5. We see a slight risk this excellence might bought at the expense of application-level research, as pointed out in the Section H2.3.

D1.2	Scope and quality of international and national cooperation and the role of the institute in such cooperation; engagement in broad international cooperation

IT names 13 international partners, ten throughout Europe and three overseas (Taiwan, Brazil, USA). The collaborations actively enable bi-directional internships of young researchers and students. IT scientists have organized eight national and international conferences and workshops during the evaluation period. All these activities prove a living participation of the IT in the international research community and provide one basis for the excellent scientific results during the evaluation period. Based at the geographical centre of Europe, the institute radiates with excellence into the international research community.

The commission follows the IAB feedback, that a strategic focus should be laid in the ability to develop a scientific focal points and an organizational structure that allow for leading roles in large European projects, including the role of the project coordinator. The IAB concludes that, to achieve this goal, a structure for the organization of projects on a European level needs to be established.

IT has reacted to this analysis and initiated negotiations in the second half of 2019 aiming at the attendance of EERA – the European Energy Research Alliance. On February 20, 2020, IT has joined EERA_CZ, an umbrella organization associating Czech EERA members. The intention is to apply for three Joint Programs of EERA as an associate member in the subsequent step; namely the Energy Storage, Carbon Capture and Storage, and Fuel Cells and Hydrogen. The focus on energy future technology is well selected.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)

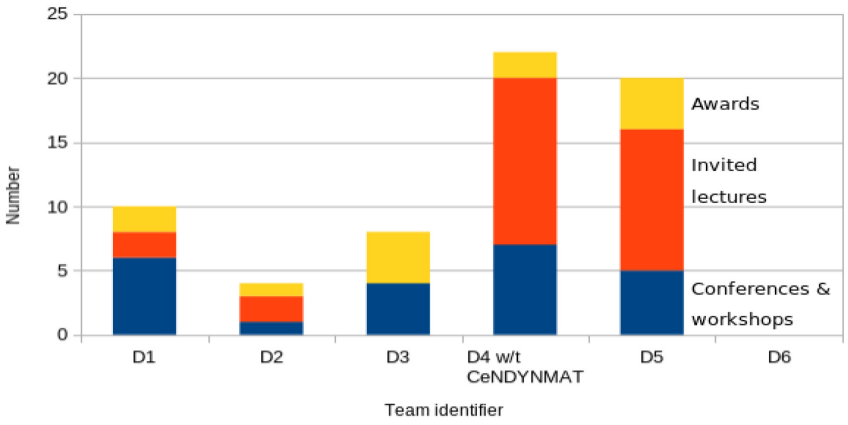


Figure: Participation of team members in activities of scientific community according to [A6]

The participation of the team members in activities of scientific community is regarded as adequate for the teams D1-D5, see figure above.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
Yes, apparently.	
D2.2	**Assessment of the previous research objectives and their achievement**
See evaluation report of the previous evaluation period.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
All teams have gradually referred to the past recommendations.	
D2.4	**Success in receiving grants**
The institute acquired 80 competitive grants during the evaluation period, which produced a budget share of 13322k€ (35%). This must be regarded as great success. The distribution of the received funds over the six teams is shown in the introduction section of this document. The received funding is primarily Czech Republic based (GACR, EC, MEYS, MIT, MI, TACR, CAS). Only a single EU Horizon 2020 project with the University of Manchester and EMTD Ltd. (UK) is reported. The commission agrees with the IAB and the director that an increase of EU funding was adequate for an institute of this scientific size and weight. First steps towards an improvement of this are incubated, cf. section D1.2	
D2.5	**Adequacy of instrumental equipment**
IT owns highest-quality and up-to-date research infrastructures and information technology facilities which are regarded as adequate by the commission. Highlights of the instrumental equipment are the high-speed aerodynamic Laboratory in Nový Knín, the low-speed wind tunnels for the investigation of turbulent boundary layer and environmental engineering, accurate measurements of thermophysical properties of fluids under extreme conditions, Laboratory of Rotational Vibrometry supported from the EU	

project investigating rotating blades of rotary machines, e.g., in power and airplane engineering, Laboratory of Ultrasound Methods using the resonant ultrasound spectroscopy (RUS) together with the temperature resolved Brillouin spectroscopy for measurement of elastic constants of materials, or the in-house developed techniques for the non-destructive testing (NDT) based on the nonlinear elastic wave spectroscopy (NEWS) and the time-reversal acoustics.

D2.6	Effectiveness of management

As far as the commission can see it, IT is very well managed. The Director Jiří Plešek is leading the institute very successfully and with great experience.

Besides this positive overall impression, a rational measure for management effectiveness cannot be provided, for the reason of unavailable performance data.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

By December 2019, the institute employed 234 persons (183,5 FTE), out of which 144 were researchers (109,53 FTE). Researcher employees are attributed to six qualification/salary categories denote by V1 (assistant) to V6 (leading researcher), defined by the CAS. As of 2019, almost half of the researchers (71 persons or 51.13 FTE) have been employed in the category V5 or higher, indicating a dominating group of established and leading researchers in the institute.

The evaluation commission agrees with the international advisory board and the director that the overall age structure of the institute is a central challenge for the next years. The large group of established and leading researchers guaranties the high scientific quality today, but to keep excellence, the generation exchange needs to be advanced. Today, IT centres the recruitment around the development of own talented graduate and post-graduate students. A “general shortage of prospective researchers in the Czech Republic” is stated [A2], which in view of the offered part-time contracts for PhD students, starting with 20% (!!) positions, is no wonder.

The institute may consider to additionally develop/intensify international recruitment routes, which would gradually help to improve the internationalization of IT altogether. There exists valuable experience in attracting new employees from abroad, also from western countries, even at the senior level and for management positions, in the neighbouring Institute of Plasma Physics, for example. Here, scientific excellence and attractive working conditions including reasonable salary levels are identified as success parameters for international recruitment; worldwide advertisement is done through web platforms like LinkedIn or Research gate as well as information spreading to foreign universities and institutions. The activities are also accompanied by the improvement of the ability of the administrative staff to communicate with foreign employees in English.

The distribution of IT researchers over the individual teams of IT is shown in the figure below. Noticeable is a group of persons aged ≥70 years, in particular in team D4/CeNDYNMAT, who form a subgroup of 22 seniors holding part-time positions (0.3-0.5 FTE per person). The institute regards this group as indispensable for education, know-how and contacts [A2]. It may be noted, though, that the comparably small and young team D5 was able to produce highest-rated outputs, which are over-proportionally selected as “main research results” of the institute, even without in-team support by such senior researchers.

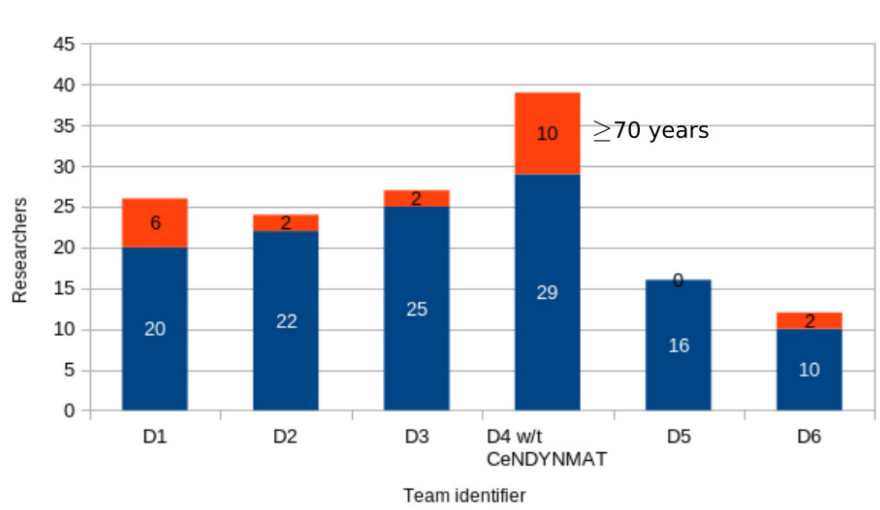


Figure: Number of researchers per Team as of Dec. 2019. Fractions of researchers ≥70 age are indicated [A2],[A6].

D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

The gender balance of the institute was not mentioned in document [A2], nor in the oral presentation of the director. Upon request the director referred to the minor proportion of women in technical degree courses in general as reason for existing misbalance in his own institute.

A friendly awareness of the differences between male and female career progressions is a success parameter of modern HR development, namely the strive for the „best minds“. There are advances towards a fresh and modern HR policy present in the institute (see team D5), and certainly in the neighbouring I. Plasma Physics, for example, which are recommended as „better practice“ examples.

D2.9	**Relation of the institute with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**

None of the documents made available to the commission refers to this program.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**

The IT belongs to the backbone of the higher education of the Czech Republic in the field of engineering and physics. The Institute has a close collaboration with most Czech universities in the field of engineering and physics, which covers operation of five joint laboratories, regular solutions of joint projects of both basic and applied research, and the education of undergraduate and postgraduate students. The Institute acts as a co-guarantor of six doctoral programs in engineering and physics.

D3.2	**Effectiveness of joint research centres**

IT reports three joint research centres:

- The Centre of Mechatronics with the Faculty of Mechanical Engineering, Brno University of Technology, based there. The centre is specialized in the research in

the field of mechatronics and biomechanics. The centre was founded on September 30, 1997.

- The Centre of Power Engineering with the Faculty of Mechanical Engineering, Czech Technical University in Prague. The centre is specialized in the research of thermodynamics, fluid dynamics and mechanics of complex systems exploitable in the field of power engineering. The Centre was founded on September 30, 1998.
- The Centre of Smart Systems and Structures with the Institute of Thermomechanics and VSB-Technical University of Ostrava, based there. The centre is specialized in the research in the field of coupled multi-physical phenomena, contact problems, and identification of atmospheric pollution. The centre was founded on December 12, 2005.

There are no figures about the effectiveness of these centres provided.

D3.3	Success rate in supervision of PhD students

The IT reports 15 successfully defended PhD theses during the evaluation period, resulting into an average success rate of 3/year. The contributions of the six teams in shown in the figure below.

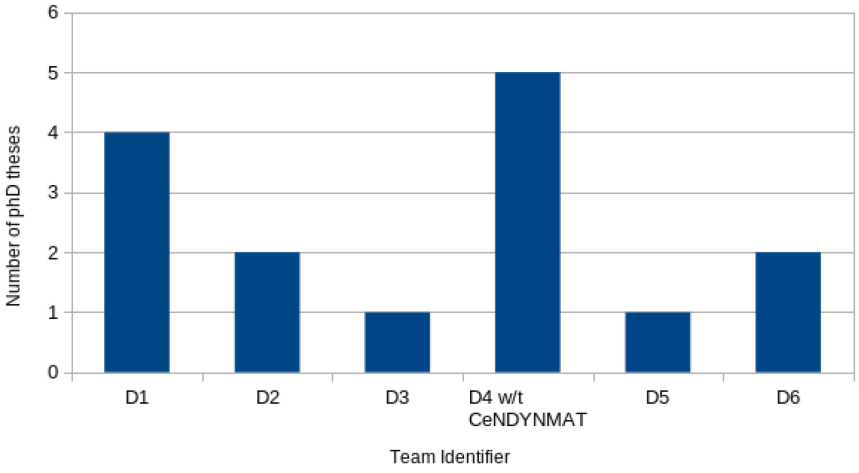


Figure: Number of defended PhD theses during the evaluation period. [A6].

D3.4	Participation of PhD students in the outputs

As of documents [A6] the commission can confirm that the PhD students were actively involved in the elaboration of the research projects and appropriately participated in respective publications.

D3.5	Participation of the institute in master or bachelor studies

The institute reports 255 semestrial lectures of IT employees were given during the evaluation period (62 at bachelor level, 165 at master level and 28 at doctoral level. 57 defended theses have been supervised at the institute (21 bachelor, 21 master and 15 doctoral).

D3.6	Assessment of cooperation intensity with universities in the form of teaching

The commission appreciates the contribution of the IT to the higher engineering education in the Czech Republic very much.

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The media strategy of IT is professional and adequate.	
D4.2	**Publishing activities and its quality**
See section H of Part A.	
D4.3	**Participation in professional organisations in the area of research and development**
All teams are involved with services to national and international community organizations; for details we refer to the respective sections of Part B of this document. These activities largely refer to the academic world. The commission appreciates very much adequate and high-level contributions of IT teams altogether.	

Other comments of the commission:
The cooperation of team D6 „Electrical Engineering and Electrophysics“ to the remainder of IT appears quite limited to the evaluation commission. This might be an indicator that the integration of the former Institute of Electrical Engineering, which took place not before the year 2006, is not fully successful until today.

The present evaluation report of the Institute of Thermomechanics (abbreviated as IT) of the Czech Academy of Science (CAS) is based on four sources:

1 White papers provided by the institute, its individual teams (D1-D6) and the academy. These incorporate both information documents and statistical comprehension of the output productivity. This material was delivered to the evaluation commission online through a cloud application of CAS.

2 Oral information provided during online presentations, which took place on March 11th, 2021. The duration of each presentation was limited to 20 minutes. The speakers kindly uploaded their presentation slides to the cloud application for later reference.

3 Up to10 minutes of online interview with the nominated speakers of (2.) directly after presentation.

4 25 minutes of online discussion with the institute director.

References of Part A:

[A1] 3-2_List_of_grant_and_programme_projects.pdf
[A2] 3-1_Information_on_the_activity_of_the_institute.pdf
[A3] 3-3_Research_for_practice.pdf
[A4] 3-5 Number_of_all_scientific_outputs.pdf (of Team)
[A5] Reports_of_the_I_phase_IT_1.pdf (of Team)
[A6] 3-4_Report_on_the_research_activity_of_team.pdf

Part B: Evaluation of teams

1. D1 – Fluid Dynamics

Strengths:

1. Three out of four laboratories have long traditions and well trained staff.
2. The head of each laboratory possess very good experiences in the field of research.
3. The team appropriately combines and integrates experimental, numerical and theoretical research.
4. There are several collaborations with companies inside and outside of the country.

Weaknesses:

1. Limited experimental facilities in terms of size and range of possible conditions as well as slow integration rate of new measurement techniques and data analysis technologies.
2. The number of peer-review publications is too low considering the number of researchers in the team.
3. Hosting international master and PhD students for short and medium-term research stays as well as co-supervision of international PhD students are not sufficiently developed.
4. The team has not enough exchange with other teams of the Institute of Thermodynamics and other relevant units with the CAS.

Opportunities:

1. To create new partnerships with commercial software provider to ensure uptake and integration of the research results.
2. Enhance the international exchange of researchers and improve the international visibility through a better website and more social media activities. It is suggested to create a medium-term strategy that clearly outlines the goals, actions and progress monitoring mechanisms.
3. Move to new research areas with high industrial and societal relevance and seek partnerships at EU level.

Threats:

1. Fast international developments in emerging and groundbreaking fields that are characterized by high social relevance such as drones, electrified aircrafts, hyperloop technologies, etc.
2. Commercial software tools for FEM simulations, CFD simulations, and data processing that allow less experienced users fast adoption and learning.
3. Low attractiveness for young talents due to missing perspectives, low international visibility and exchange, limited openness to emerging (fascinating) topics.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The outputs of Phase I are of good quality. The scientific publications are in appropriate journals of the field.	

H1.2	Contribution of workers on the outputs reached
The team members contributed in reasonably high amounts, ranging from 10 to 100%, to the outputs.	
H1.3	**Quality of all outputs and results**
The quality of all outputs and results is good. The number of scientific papers is too low considering the number of researchers in the team. The number of national and international conference contributions is appropriate.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Each laboratory list 3 to 4 key results that are linked to several publications and projects. Laboratory of Internal Flows: Complex 3d turbulent flows; Laboratory of Turbulent Shear Flows: Passive and active shear flow control; Laboratory of Environmental Aerodynamics: Short-time release of hazardous materials in complex terrains; Laboratory of Computational Fluid Dynamics: Application of turbulence models.	
H1.5	**Contribution of the participation of the authors in large collaborations**
N/A	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
The team does not have a compelling and clear mission that is communicated to the broader public. The societal relevance of the research work of the Laboratory of Environmental Aerodynamics is fully justified. The societal relevance of the other three laboratories is not clearly communicated.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
The system functionality for knowledge transfer is good. The knowledge transfer occurs through several collaborations with national and international companies as well as universities.	
H2.3	**Relation to practice**
The research topics have clear relations to practice. Nevertheless, the number of interactions and projects should be further increased to fully exploit the potential of the experimental and theoretical facilities and the researchers' capabilities.	
H2.4	**Participation in AV21 strategy**
Yes.	
H2.5	**Cooperation with regions of the Czech Republic**
The team collaborates with a good number of partners within the country.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
The academic track record in terms of peer-reviewed publications, patents and participation in and coordination of EU projects is below the international average.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The scope of the cooperations is in line with the capabilities of the team. Collaborations are mainly at partner level. In the future the team needs to initiate more cooperations in the position of a coordinator and leader.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The researcher are engaged in several activities at local and national level. The visibility at international level needs to be further improved. In this regard, CAS has to make sure that sufficient financial support of such activities is provided.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
There is no clear strategy that is in alignment with emerging trends and societal or industrial needs. Furthermore, a clear vision of the future and potential new research topics are not sufficiently detailed.	
D2.2	**Assessment of the previous research objectives and their achievement**
Previous research objectives were good and their achievement has been documented through several relevant publications in peer-reviewed journals with impact factor.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations are partly implemented. The number of collaborations has improved. The number of peer-reviewed publications in journals with an impact factor is almost similar. More emphasis is needed to further increase the number of publications per researcher.	
D2.4	**Success in receiving grants**
The team is successful in receiving grants at the national level. However, the participation in international grants is very limited. More efforts and the implementation of a clear strategy are needed.	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment is good. However, the teams need constant investments in the latest technologies to develop and maintain leadership in the field. Specialization in key research directions helps to support investment decisions. Furthermore, the quality of equipment is linked to income from industry collaborations and funding organizations.	

D2.6	Effectiveness of management
The effectiveness of the management is limited. There are no clear procedures to ensure scientific excellence and impact at international level through visibility and high-quality outputs.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
There is no clear strategy to ensure career development for young scientists, professional development of principal investigators and to attract new talent. A weakness is the missing exchange of young and talented students and researchers.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The work-life balance conditions are appropriate. The team lacks sufficient gender balance. It is suggested to create and implement a strategy to achieve gender balance in the medium to long-term.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
N/A	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The scope of cooperation focuses on the co-supervision of national bachelor, master and PhD students. It is suggested to host more students from abroad as well as postdoctoral associates for short to medium-term research stays in the team.	
D3.2	**Effectiveness of joint research centres**
Some of the team members are involved in joint research centres at TUP and TUL.	
D3.3	**Success rate in supervision of PhD students**
The success rate in supervision of national PhD students is appropriate.	
D3.4	**Participation of PhD students in the outputs**
The participation of PhD students in the output sis appropriate. I tis advised to conduct co-supervision of international PhD students, e.g. as member of the thesis committee.	
D3.5	**Participation of the team in master or bachelor studies**
The supervision activities of master and bachelor students are appropriate. It is suggested to host also international master students for their master thesis project.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The teaching activities at universities are appropriate.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
There is no state-of-the-art media strategy with sound goals and audience-specific activities. The outreach activities are limited to the team website, open-door-days and a couple of public lectures at local and national level. It is suggested to develop and implement a strategy that improves in particular the website and the social media activities of the team. Overall the international visibility is low.	
D4.2	**Publishing activities and its quality**
There are no clear publishing activities that target on the general public.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members are involved in a number of scientific councils at local level (UWB, TUL). The visibility of the team in professional organisations at national and international level is not pronounced and can be improved. CAS needs to ensure sufficient funding to participate in national and international person-to-person meetings.	

Other comments of the commission:

The scientific performance is below average considering the size of the team. The integration of young and capable researchers with international experiences that work on new, emerging topics is needed.

2. D2 – Thermodynamics

Strengths:

- Highest-level expertise due to top scientists in specific, albeit narrow fields of science.
- Very fine, specialized equipment
- Seamless integration in the international research community

Weaknesses:

- Limited relation to the application level ("research for practice"): Little contribution to contracted work, no patents licensed in evaluation period.

Opportunities:

- Increase of contracted work share and improvement of its profitability.
- Improvement of exchange with industry
- Identification of fresh activities with societal relevance

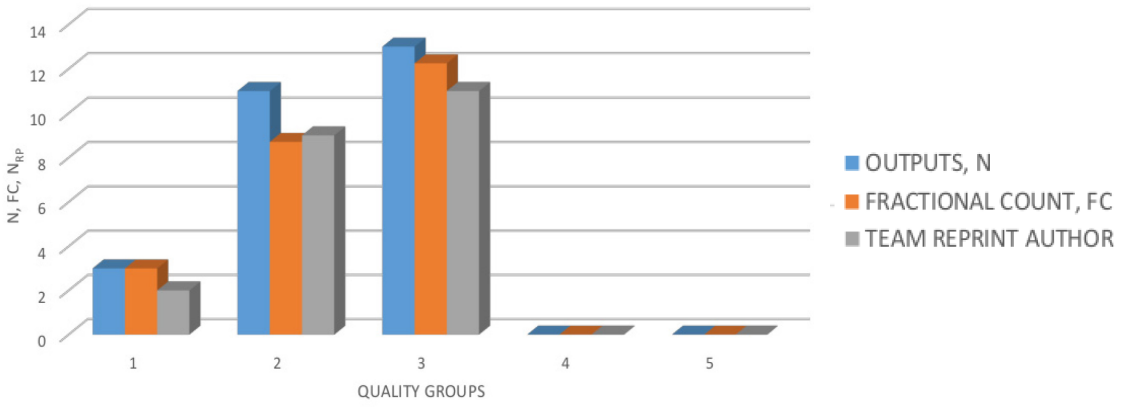
Threats:

- The challenge of the coming generation exchange.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

Team D2 has submitted 27 outputs to phase I of the present evaluation process. On average, these yielded a rating of 2.37, which is the next best rating of all six IT teams. In terms of quality, this result is well above the mean value of IT (2.61). According to the definition of quality levels by the CAS, the outputs of team D2 on average fall into the category 2(-): highest standards of excellence and likely future significant innovative potential. The commission appreciates this result very much. The distribution of the outputs over the five possible QL is shown in the figure below [B3]:



H1.2	Contribution of workers on the outputs reached

To rationalize the contribution of workers to the outputs submitted to phase I, the mean fractional count FC/N may be employed, where FC=A/B is the fractional count of the number A of the authors in team D2 and the total number B of all authors of all submitted outputs of D2, and N is the number of outputs submitted by D2 (27).

Team D2 has achieved a mean fractional count of FC/N=0.89, which means that the respective results were almost entirely produced by the team itself. In view of the high QL of 2.37 (see section above), the commission appreciates team D2 as a top output performer of the institute altogether.

H1.3	Quality of all outputs and results

The documents [B2] list a total of 190 publications by team D2 during the evaluation period. These were not reviewed during phase II in detail. Therefore, no comment can be given on quality regarding all these outputs.

The D2-share of all IT outputs was 21%, which is approximately proportional to the team size fraction (18% of FTE of the IT).

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

- Thermodynamic modelling of the properties and phase equilibria of gas hydrates. The new model for eight gas hydrates is compatible with accurate multiparameter equations of state for fluid phases and ices. The model was implemented in the software package TREND 2.0 and can be used for practical design of CCS (Carbon Capture and Storage) technologies. Published as three-parted article series in the journal Fluid Phase Equilibria 2016-2017.
- Development and optimization of the fluid jet actuators: Cooling of miniature electronic components can be realized by periodic fluid jets generated by a resonant cavity driven by an oscillating diaphragm. An optimization obtained a significant enhancement of the energetic efficiency up to 2.5 times higher values comparing to available devices. The theoretical results were confirmed experimentally. The results have been published in leading journals 2017-2019.
- Development and testing of a unique, laboratory-scale plasma source for a magneto-cumulative electricity generator, published in the journal Energy 157 (2018) 493-502.

H1.5	Contribution of the participation of the authors in large collaborations

The team actively participates in the work of the International Association for the Properties of Water and Steam (IAPWS).

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The term “relevance” is ambiguous. The institute serves important contributions to the higher education of engineers in the Czech Republic (see Sections D3.1-D3.6). Traditionally rooted in the field of mechanical and the power engineering, the institute today preserves and advances the art of engineering alike. The fields of activity (fluid/solid mechanics, thermodynamics and electrical engineering) belong to the fundamental core subjects of engineering, essential for both preservation and progress of the technological systems driven by a developed industrial society like the Czech Republic. In these regards, the work of IT is certainly highly relevant to the society.

The team D2 states that “the research only weakly touches problems of highest social and scientific interest” in the oral presentation, see document [B5].

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities
See section H.2.3	
H2.3	**Relation to practice**
In the document [B5], the team D2 refers to four industry collaborations (WIKOV GEAR, ŠKODA AUTO, THERMO INDUSTRY and CLASSIC OIL). As of document [B4], the team D2 has conducted a total of 5 contracted works which yielded a total revenue of 16 k€ in five years only. All of these contracts produced revenues below 10 k€. This result appears to be fairly under the potential of the team's abilities that could easily find markets. See also the respective comment in Part A of this report.	
H2.4	**Participation in AV21 strategy**
According to the document [B1], the team D2 refers to the following three projects: • Laboratory of Energy Storage (LES) was established aiming at strengthening of collaboration of the Czech Academy of Sciences with state and public institutions as well as with commercial subjects, and at strengthening the collaborations among various institutes of the Czech Academy of Sciences. • Collaboration with the Institute of Chemical Process Fundamentals of the CAS: Joined Laboratory for Thermal Energy Storage was established to use effectively complementary experimental methods and theoretical approaches. • Collaboration with the Institute of Informatics of the CAS: Collaborative project on the application of advanced statistical method to thermophysical properties data.	
H2.5	**Cooperation with regions of the Czech Republic**
There is no reference to regional cooperation in the activity report [B1] of this team.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
This request is hard to answer, because of largely different economical situations in different countries. Since IT belongs to the Czech national academy of science, the comparison had to be drawn nationally funded research institutions like Institutes of the Max Planck Society (fundamental research), the Helmholtz Association (big science) or Fraunhofer Gesellschaft (applied research) in Germany, for example, which together received an annual budget of 9.4 billion € in 2019, however. Therefore, a direct comparison with such institutions is unfair. All despite this, the Team D2 is able to coin its own scientific footprint in the European research landscape, mainly due to decent, homegrown expertise, sometimes even at world-leading excellence. We see a slight risk this excellence might bought at the expense of application-level research, as pointed out in the Section H2.3.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
According to the document [B1], the team participated in 6 international cooperation with partners in Germany (Bochum, Dresden), France (Lyon), The Netherlands (Eindhoven), Norway (SINTEF) and Australia (Sydney).	

The activities refer predominantly to academic research. The participation in the work of the International Association for the Properties of Water and Steam (IAPWS) may be highlighted. The scope of the international collaboration is adequate and the partner institutions are known for highest research quality. With reference to the comments in section H2.3, the team might consider to extend the cooperation also at the application level.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
The team D2 is actively participation in the scientific community. The team leader serves as the president the International Association for the Properties of Water and Steam (IAPWS). Further participations refer to panel P101 of the Mechanical Engineering of the Czech Science Foundation (GACR), the panel Petromaks 2 of the Research Council of Norway, the board for doctoral studies in the area of Thermomechanics and Fluid Mechanics at Czech Technical University in Prague and the board for doctoral studies in the area of Thermodynamics and Fluid Mechanics at the Technical University of Liberec. During the evaluation period, the team has organized one international conference, contributed two invited lectures and received one award. The evaluation commission appreciates all these excellent activities very much.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
Yes, apparently.	
D2.2	**Assessment of the previous research objectives and their achievement**
See evaluation report of the previous evaluation period.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The team has referred to the past recommendations in document [B1].	
D2.4	**Success in receiving grants**
The team D2 has received 19 grants from competitive funding during the evaluation period, in total of 2392 k€, or 18% of the total competitive funding of the institute. Thus there is a balanced proportionality to the team size (which is 18% of FTE of IT). The funding agencies were entirely Czech Republic based, with the only exception of a collaborative project with the SINTEF, which received co-funding from the state of Norway (for the foreign work-packages). See also comment in section D2.4 of Part A of this report.	
D2.5	**Adequacy of instrumental equipment**
As far as the commission can judge from remote, the instrumental equipment of team D2 is adequate and excellent. We highlight the accurate devices for the measurement of thermophysical properties of fluids under extreme conditions.	
D2.6	**Effectiveness of management**
As far as the commission can see is the team D2 very well managed. Besides this positive overall impression, a rational measure for the management effectiveness cannot be provided, for the reason of unavailable performance data.	

D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
Today, the team D2 has developed personnel expertise required for the excellent research in the chosen field of activity. This personnel is the most important success parameter of the team and incorporates personalities belonging to the top scientists in specific, albeit narrow fields of science. These experts seem to have ripened together to the present excellence, and this necessarily bears the risk of thematic inclusion. “Difficulties in hiring post-docs”, as stated in the document [B5], can be understood as a foreshadow of this. Therefore, an advance towards the coming generation exchange is seen as the main challenge of this team for the coming years. Young talents, male or female, prefer to avoid trodden paths. So the commission would encourage the team to also seek for fresh scientific activities with societal relevance, e.g. in the field of regenerative energy supplies. This is the high arts of HR development. Maybe new recruitment routes mentioned in comment D2.7 of Part A can prove helpful.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The gender balance of the institute was not mentioned in document [B1], nor in the oral presentation. Please refer to the comment D2.8 of Part A.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
None of the documents made available to the commission refers to this program.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
The scope of cooperation is due to (excellent) academic research institutions, mostly with universities.	
D3.2	**Effectiveness of joint research centres**
In the document [B1] the team refers to the research centre for low-carbon energy (project [C]) coordinated by the Czech University in Prague (research in the field of CO2 capture from combustion processes using biomass and utilization of the captured CO2	
D3.3	**Success rate in supervision of PhD students**
During the evaluation period, the team D2 has supervised two successfully defended PhD theses.	
D3.4	**Participation of PhD students in the outputs**
As of documents [B1], the commission can confirm that the PhD students were actively involved in the elaboration of the research projects and appropriately participated in the respective publications.	
D3.5	**Participation of the team in master or bachelor studies**

As of documents [B1], team D2 contributed nine semestrial master-level lectures, supervised/advised two master theses and supervised /advised 6 PhD theses out of which two were successfully defended during the evaluation period.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The lecturing share of team D2 w.r.t. the total semestrial lecturing of IT is 3.5%, which appears quite under-proportional.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
See respective comment in Part A of this document.	
D4.2	**Publishing activities and its quality**
Please see section H	
D4.3	**Participation in professional organisations in the area of research and development**
See section D1.3	

Other comments of the commission:
None

3. D3 – Dynamics and Vibration

Strengths:

- Tradition in the field of dynamics and vibration
- Excellent combination of experimental and theoretical research
- Advanced experimental facilities
- Collaboration with universities and industry worldwide
- Runs the only EC-granted project (H2020)

Weaknesses:

- It is expected that the ongoing generation transition may cause a quantitative dip of IF journal publications in the next evaluation period. (This, however, must be regarded as natural process.)
- The fruitfulness of the experimental research is dependent on regular investments. (General issue)

Opportunities:

- The generation exchange has been incubated
- Increase of contracted work share and improvement of its profitability.

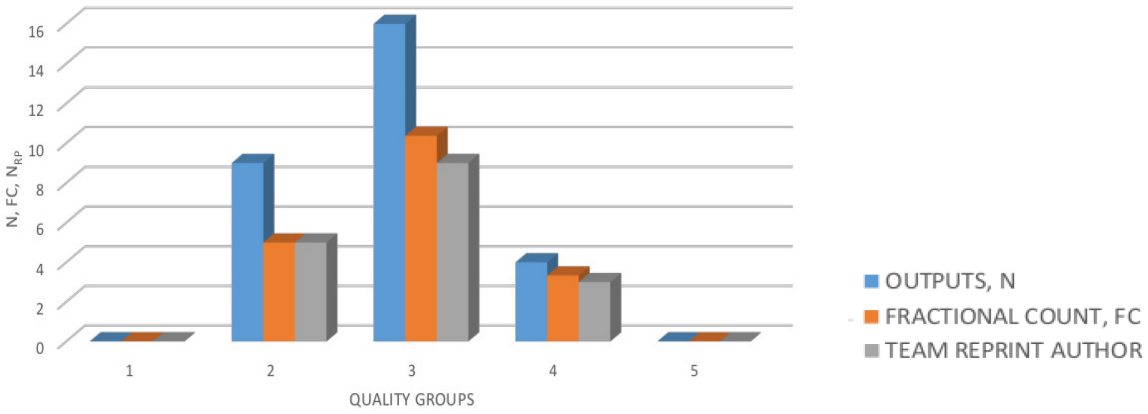
Threats:

- None

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

Team D3 has submitted 29 outputs for evaluation during phase I. On average, these yielded a rating of 2.83, which (in terms of quality) is below the mean value of IT (2.61). According to the definition of quality levels by the CAS, the outputs of team D3 fall on average into the category 3(+): recognized internationally and appreciated as of recognizable novelty, with actual or likely future innovative potential. The commission appreciates this result. The distribution of the outputs over the five possible QL is shown in the figure below [B3]:



H1.2	Contribution of workers on the outputs reached

To rationalize the contribution of workers to the outputs submitted to phase I, the mean fractional count FC/N may be employed, where FC=A/B is the fractional count of the

number A of the authors in team D3 and the total number B of all authors of all submitted outputs of D3, and N is the number of outputs submitted by D3 (29).

Team D3 has achieved a mean fractional count of FC/N=0.64, which means that the respective results were produced approximately to two thirds by the team itself, which is close to the mean value (0.67) of all teams of IT.

H1.3	Quality of all outputs and results

The documents [B2] list a total of 225 publications by team D3 during the evaluation period. These were not reviewed during phase II in detail. Therefore, no comment can be given on quality regarding all these outputs.

The D3-share of all IT outputs was the highest of the institute (25%), which is over proportional in comparison to the team size fraction (18% of FTE). But the achieved QL during phase I was moderate. This is an indication that the publication strategy might benefit from an adjustment from quantity towards quality.

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

The team develops highly sophisticated new methods and equipment for the calibration and laboratory testing of the non-contact vibrodiagnostics systems. These are useful for the diagnosis of rotating blades of large blade machines. Additionally, an electromagnetic simulator of rotating machine blades was developed. The results have been published 2018 in a series of three papers which were published in the journal IEEE Transactions on Instrumentation and measurement.

H1.5	Contribution of the participation of the authors in large collaborations

- The team D3 is project partner of the EU Horizon2020 project "Batista - Blade Tip Timing System Validator", ID 862034, Call Clean Sky 2. The consortium set up for this project has EMTD (Coordinator - GB) and the University of Manchester (GB) as further members. SAB (Safran Aero Boosters - BE) is engaged in the project as a supervisor.
- The D3 team contributes a work package within the National Centre for Energy, the Technology Agency of the Czech Republic project no. TN01000007 which associates 23 research institutes, universities and companies.

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The term “relevance” is ambiguous. The institute serves important contributions to the higher education of engineers in the Czech Republic (see Sections D3.1-D3.6). Traditionally rooted in the field of mechanical and the power engineering, the institute today preserves and advances the art of engineering alike. The fields of activity (fluid/solid mechanics, thermodynamics and electrical engineering) belong to the fundamental core subjects of engineering, essential for both preservation and progress of the technological systems driven by a developed industrial society like the Czech Republic. In these regards, the work of IT is certainly highly relevant to the society.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities
See section H.2.3	
H2.3	**Relation to practice**
In the document [B5], the team D3 refers to three industry collaborations (Turbine producer Doosan Skoda Power, a.s., Gear-box producer Wikov Gear, s.r.o., Railway wheel producer BONATRANS GROUP a.s., Bohumín). As of document [B4], the team D3 has conducted a total of 6 contracted works which yielded a total revenue of 27 k€ in five years only. All of these contracts produced revenues below 10 k€. This result appears to be fairly under the potential of the team's abilities that could easily find a market. See also the respective comment in Part A of this report.	
H2.4	**Participation in AV21 strategy**
According to the document [B1], the team D3 refers to the following two projects: • Participation in the program VP03 - Effective energy conversion and storage: Project Vibrodiagnostics of rotating blades of rotary machines in power engineering • Participation in the program "Efficient Energy Transformation and Storage": Investigation of the flywheel technology.	
H2.5	**Cooperation with regions of the Czech Republic**
There is no reference to regional cooperation in the activity report [B1] of this team.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
This request is hard to answer, because of largely different economical situations in different countries. Since IT belongs to the Czech national academy of science, the comparison had to be drawn nationally funded research institutions like Institutes of the Max Planck Society (fundamental research), the Helmholtz Association (big science) or Fraunhofer Gesellschaft (applied research) in Germany, for example, which together received an annual budget of 9.4 billion € in 2019, however. Therefore, a direct comparison with such institutions is unfair. All despite this, the Team D3 is able to coin its unique and visible scientific footprint in the European research landscape, especially in the field of non-contact vibrodiagnostics.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team refers to many international cooperations with partners from Taiwan (Tainan City), Poland (Cracow, ITWL), Finland (Tampere), Austria (Vienna), UK (Manchester), Italy (Torino, Perugia, Pisa, Rome), Vietnam (Hanoi), Russia (Orel) and France (Besancon). Additionally, there are many collaborations at national level. The activities refer predominantly to academic research. The participation in the only H2020 granted project of IT can be highlighted.	

The long list of international partners speaks for itself; the partner institutions are known for highest research quality. With reference to the comments in section H2.3, the team might consider to extend the cooperation also at the application level.
D1.3 **Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The team D3 is actively participating in the scientific community. The team leader serves as chairman of the national section of the GAMM and he is a member of the international technical committee Vibration in the world federation, IFTOMM, as well as in 5 other organizations. Three other team employees serve in eleven further organization units, both internationally and nationally. During the evaluation period, the team has organized four conference and received four awards. The evaluation commission appreciates all these excellent activities very much.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
Yes, apparently.	
D2.2	**Assessment of the previous research objectives and their achievement**
See evaluation report of the previous evaluation period.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The team has referred to the past recommendations in document [B1].	
D2.4	**Success in receiving grants**
The team D3 has received 12 grants from competitive funding during the evaluation period, in total of 1451 k€, or 11% of the total competitive funding of the institute. Thus there is a slight under-balance in regard to the proportionality in comparison to the team size (which is 18% of FTE of IT). The funding agencies were entirely Czech Republic based, with the exception of a EU H2020 funded collaborative project, which is the only one of IT and therefore must be appreciated. See also comment in section D2.4 of Part A of this report.	
D2.5	**Adequacy of instrumental equipment**
As far as the commission can judge from remote, the instrumental equipment of team D3 is adequate and excellent. We highlight the Laboratory of Rotational Vibrometry used for the investigation of rotating blades of rotary machines, e.g., in power and airplane engineering.	
D2.6	**Effectiveness of management**
As far as the commission can see is the team D3 very well managed. Besides this positive overall impression, a rational measure for the management effectiveness cannot be provided, for the reason of unavailable performance data.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The generation exchange is an urgent topic also for the team D5. Several senior scientists were recently retired and others are close to retirement. As of document [B1], there was successful recruitment, also from abroad, but the process of handing over the expertise is	

not completed yet. The team expects a dip in near-future output performance for this reason.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The gender balance of the institute was not mentioned in document [B1], nor in the oral presentation. Please refer to the comment D2.8 of Part A.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
None of the documents made available to the commission refers to this program.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
The scope of cooperation is due to (excellent) academic research institutions, mostly with universities.	
D3.2	**Effectiveness of joint research centres**
As of document [B1], several members of the D3 team are active in two joint centres: • Centre of Mechatronics in Brno University of Technology • Centre of Intelligent Systems and Structures in Technical University of Ostrava. There is no data about the effectiveness of these centres provided.	
D3.3	**Success rate in supervision of PhD students**
During the evaluation period, the team D3 has supervised a single successfully defended PhD thesis.	
D3.4	**Participation of PhD students in the outputs**
As of document [B1], the commission can confirm that the PhD students were actively involved in the elaboration of the research projects and appropriately participated in the respective publications.	
D3.5	**Participation of the team in master or bachelor studies**
As of document [B1], team D3 contributed six semestrial bachelor-level lectures, 25 semestrial master-level lectures and ten semestrial lectures at doctoral level. Additionally, the team supervised/advised a single master thesis and supervised /advised two PhD theses out of which one was successfully defended during the evaluation period.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The lecturing share of team D3 w.r.t. the total semestrial lecturing of IT is 16%, which reflects a good proportion of this activity.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
See respective comment in Part A of this document.	
D4.2	**Publishing activities and its quality**
Please refer to section H	
D4.3	**Participation in professional organisations in the area of research and development**
See section D1.3	

Other comments of the commission:
(None)

4. D4 – Impacts and Waves in Solids and Centre CeNDYNMAT

Strengths:

- Strong scientific/industrial partners in research grants
- Many scientific collaborations worldwide.
- Excellent research infrastructure

Weaknesses:

Opportunities:

- Collaboration potential
- Improvement of profitability contracted work
- Improvement of the utilization of applied research results
- Emerging areas in current running technological projects

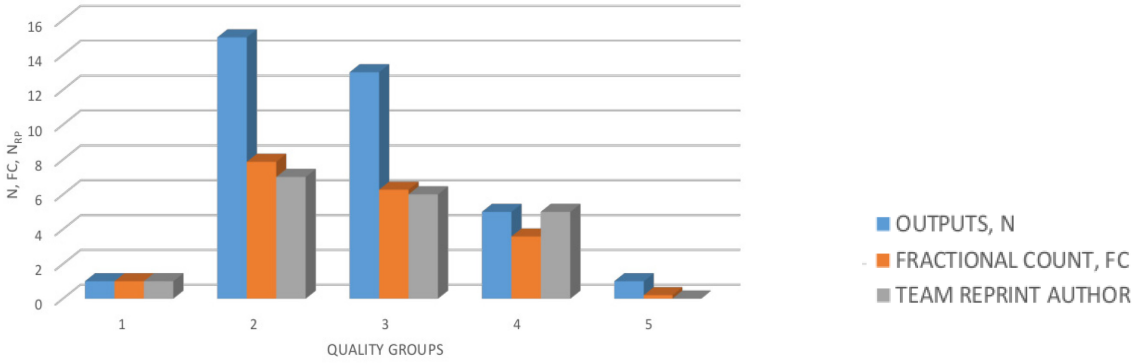
Threats:

- Age structure: (Quite) elevated age of R3/R4 researchers;

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I

Team D4 has submitted 35 outputs for evaluation during phase I. On average, these yielded a rating of 2.71, which is close to the mean value of IT (2.61). According to the definition of quality levels (QL) by the CAS, the outputs of team D4 fall into the category 3(+): recognized internationally and appreciated as of recognizable novelty, with actual or likely future innovative potential. The commission appreciates this result. The distribution of the outputs over the five possible QL is shown in the figure below [B3]:



H1.2	Contribution of workers on the outputs reached

To rationalize the contribution of workers to the outputs submitted to phase I, the mean fractional count FC/N may be employed, where FC=A/B is the fractional count of the number A of the authors in team D4 and the total number B of all authors of all submitted outputs of D4, and N is the number of outputs submitted by D4 (35).

Team D4 has achieved a mean fractional count of FC/N=0.54, which means that the D$ employees contributed to the approximate half of the results on average, which is below the mean value (0.67) of IT. This is slightly astonishing in view of team size (39 researchers / 24.75 FTE as of the year 2019), which is the largest in the institute.

H1.3	Quality of all outputs and results

The documents [B2] list a total of 133 publications by team D4 during the evaluation period. These were not reviewed during phase II in detail. Therefore, no comment can be given on quality regarding all these outputs.

The D4-share of all IT outputs was 15%, which is under proportional in view of the team size fraction (24% of FTE).

H1.4	The most valuable discoveries and findings in the fields, their importance for the field

- Wave motion in a thick cylindrical rod undergoing longitudinal impact: The team contributed a highly accurate and comprehensive solution for the longitudinal impact problem of thick elastic rods. The solution is analytically derived and the resulting conditional equations are derived using the residue theorem. Based on the results, transient wave phenomena can be explained at great detail. The work was published 2016 in the journal Wave Motion.
- The team developed a method to calibrate a directional-distortion hardening model for metal plasticity by analytical means. The model yields equations for the material-inherent stress–strain curve, the hysteresis loop and the cyclic stress–strain curve. The work was published 2018 in the International Journal of Solids and Structures.

H1.5	Contribution of the participation of the authors in large collaborations

The team D4 participated in two National Competence Centres of the Technology Agency of the Czech Republic (TACR): The National Competence Centre-Cybernetics and Artificial Intelligence (NCK-KUI) and the National Centre of Competence for Materials, Advanced Technologies, Coatings and their Applications (NCK-MATCA)

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The term “relevance” is ambiguous. The institute serves important contributions to the higher education of engineers in the Czech Republic (see Sections D3.1-D3.6). Traditionally rooted in the field of mechanical and the power engineering, the institute today preserves and advances the art of engineering alike. The fields of activity (fluid/solid mechanics, thermodynamics and electrical engineering) belong to the fundamental core subjects of engineering, essential for both preservation and progress of the technological systems driven by a developed industrial society like the Czech Republic. In these regards, the work of IT is certainly highly relevant to the society.

H2.2	System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities
See section H.2.3	
H2.3	**Relation to practice**
The document [B5] refers to expert support of the State Office for Nuclear Safety (SÚJB) for defects evaluation and vibration of nuclear components. As of document [B4], the team D4 has conducted a total of 16 contracted works which yielded a total revenue of 201 k€. Nine out of these 16 contracts produced revenues below 10 k€ and six between 10 und 30 k€. Only a single contract produced a higher revenue of 71 k€; this contract dealt with “expert support in the field of independent assessment of flaws evaluation in welded components” and spanned a runtime of 24 months; the task description was: “independent assessment of flaws evaluation in welded components, the elaboration of a study on “weld overlay” (WOL) for repairs of heterogeneous welded components in NPPs and calculation of the critical and the maximum acceptable flaw in heterogeneous welds used in the emergency power supply nozzle of steam generator EDU.” [B4] Comment: In view of runtime and complexity, the revenue of the 71 k€-project appears underrated and can hardly cover full costs required for contracted work. (See also comment in the respective section H2.3 of Part A).	
H2.4	**Participation in AV21 strategy**
There is no reference to the AV21 strategy in the activity report [B1] of team D4.	
H2.5	**Cooperation with regions of the Czech Republic**
There is no reference to regional cooperation in the Czech Republic in the activity report [B1] of this team.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
This request is hard to answer, because of largely different economical situations in different countries. Since IT belongs to the Czech national academy of science, the comparison had to be drawn nationally funded research institutions like Institutes of the Max Planck Society (fundamental research), the Helmholtz Association (big science) or Fraunhofer Gesellschaft (applied research) in Germany, for example, which together received an annual budget of 9.4 billion € in 2019, however. Therefore, a direct comparison with such institutions is unfair. All despite this, the Team D4 is able to coin its unique and visible scientific footprint in the European research landscape, especially in the field of advanced metal plasticity.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team refers to 25 international collaborations with partners from all over the world. The long list well reflects that the team’s foundation was rooted in the framework of the EU operational program Research, Development and Education, call “Support to Excellent Research Teams” under a leadership of Prof. Yannis F. Dafalias (USA). The foundation of	

the Centre of Excellence for Nonlinear Dynamic Behaviour of Advanced Materials in Engineering (CeNDYNMAT) in the year 2016 must be highlighted. It refers also to the collaboration with Prof. Yannis F. Dafalias under co-funding of the US DoD, as well as bilateral projects provided by CSF/MEYS and French region Val de Loire. Several academic exchange visits were supported by CAS and mobility project provided by MEYS. The long list of international activities speaks for itself; the partner institutions are known for highest research quality. the intense international cooperation is certainly a strength of this team.

D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Employees of team D4 serve a total of 22 positions in national and international panels, boards, commissions or committees of the scientific community. The team has organized 7 international and national conferences, gave 13 invited lectures and received 2 awards. The evaluation commission appreciates all these excellent activities very much.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
Yes, apparently.	
D2.2	**Assessment of the previous research objectives and their achievement**
See evaluation report of the previous evaluation period.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The teams refer to the recommendations in the document [B1]	
D2.4	**Success in receiving grants**
The team D4 has received 19 grants from competitive funding, which yielded total of 5348 k€ or 40% of all IT grants during the evaluation period. This share is significantly higher than the size-fraction of the team (24% of all FTE of the institute). This great success is appreciated by the commission very much. The funding originated entirely from the Czech Republic. In view of the very good international contacts, the team exhibits favourable prerequisites for EC grant applications.	
D2.5	**Adequacy of instrumental equipment**
As far as the commission can judge from remote, the instrumental equipment of team D4 is adequate and excellent. We highlight the in-house developed of non-destructive testing devices based on the nonlinear elastic wave spectroscopy.	
D2.6	**Effectiveness of management**
As far as the commission can see is the team D4 very well managed. Besides this positive overall impression, a rational measure for the management effectiveness cannot be provided, for the reason of unavailable performance data.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The coming generation exchange is an urgent topic also for the team D4, especially in regard to the need of handover of expertise from established and leading researchers to	

first stage and recognized researchers. The team expects to attract young researchers by position tenders enabled by recently acquired funding. Maybe the new recruitment routes mentioned in comment D2.7 of Part A can prove helpful during this process. There is a slight concern about the large fraction of 10 senior researchers aged equal or above 70 years in this team. In comparison with most of the teams in the pool of this commission, this number is exceptional and the reason for the presence of these long-serving experts on the payroll of the institute remained unclear.

D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team reports flatly that “the HR policy of the D4 department is aligned with the policy of our institute [including] the gender balance” [B1]. The gender balance policy of the institute however, remained concealed to the commission, see comment in section D2.8 of Part A of this document.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
None of the documents made available to the commission refers to this program.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
See section D1.2	
D3.2	**Effectiveness of joint research centres**
The document [B1] refers to a cooperation with the University of West Bohemia in Pilsen in the framework of the five-year CSF project P101-12-2315.	
D3.3	**Success rate in supervision of PhD students**
During the evaluation period, the team D4 has supervised five successfully defended PhD theses. The commission appreciates this result very much.	
D3.4	**Participation of PhD students in the outputs**
As of document [B1], the commission can confirm that the PhD students were actively involved in the elaboration of the research projects and appropriately participated in the respective publications.	
D3.5	**Participation of the team in master or bachelor studies**
As of document [B1], team D4 contributed 20 semestrial bachelor-level lectures, 33 semestrial master-level lectures and three semestrial lectures at doctoral level. Additionally, the team supervised/advised 14 bachelor theses, three master theses and five PhD theses. Out of these, 11 bachelor theses were defended, 2 master theses and five PhD theses.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The lecturing share of team D4 w.r.t. the total semestrial lecturing of IT was 22%. The commission appreciates this contribution to the higher education very much.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
See respective comment in Part A of this document.	
D4.2	**Publishing activities and its quality**
Please refer to section H.	
D4.3	**Participation in professional organisations in the area of research and development**
See section D1.3	

Other comments of the commission:
(None)

5. D5 – Ultrasonic Methods

Strengths:
The department is highly productive and manages to perform research on a high academic level, leading to broad international collaborations. It has access to unique and in-house built experimental devices, which is a competitive plus. Additionally, the team manages to establish a young and gender-balanced team.

Weaknesses:
While the creativity of the department leads to large output on a high level it also leads to a diversification of research topics which should be counteracted by a better long-term funding and the ability to attract international team members.

Opportunities:
Due to the high-quality research and the international collaborations the team should become, in the near future, more successful in the acquisition of international projects.

Threats:
A lack of better long-term funding might lead to instabilities in the team as it depends on a few leading individuals that might not be able to always keep up the high production rate and the variety of research topics that is pursued by the department.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The department performed very well in the fields of ultrasonic methods with a focus on the development of new laser-ultrasonic devices, the applications of ultrasonic methods to advanced materials, and the modelling of advanced materials. The quality profile shows a remarkable percentage of outputs within the highest quality group.	
H1.2	**Contribution of workers on the outputs reached**
The fractional count of the department turned out to be 0.61, indicating that most of the output of Phase I was created by team members of the department themselves.	
H1.3	**Quality of all outputs and results**
The numerous outputs distribute across all quartiles by journal ranking, with a large portion of outputs being located in the top decile. This indicates a very good rating above average.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Among the valuable discoveries the development of new laser-ultrasonic methods for resonant ultrasound spectroscopy seems to be of major importance and provides a unique laboratory environment for the department. These allow, as applications, the characterisation of various advanced materials by means of ultrasonic methods. This combination is rather outstanding and is reflected in the high quality of outputs and results.	
H1.5	**Contribution of the participation of the authors in large collaborations**
None.	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Due to the sophisticated and fundamental type of the considered research, a societal relevance is not obvious. It should be noted, however, that advanced materials play a major role in many industrial processes and advanced technologies, which, in turn, are of societal relevance.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
Due to the highly specialized research, there are no immediate links to industry and it is not immediate to connect to the area of social sciences and humanities.	
H2.3	**Relation to practice**
The relation to practice could be improved – in particular by finding industry partners. This might, however, not be easy due to the highly specialized type of research.	
H2.4	**Participation in AV21 strategy**
The department takes part in the AV21 strategy and was successful in acquiring a corresponding project.	
H2.5	**Cooperation with regions of the Czech Republic**
National Cooperations are mainly limited to other teams of CAS, the Charles University, and the Brno University of Technology. There are no immediate links to national or regional industry.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
Due to the high quality of scientific outputs and a unique laboratory equipment, the team should be considered as being at the forefront of national and international research, thus being well above average.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team engages in a variety of national and international cooperations, the corresponding list in the research activity report is impressive and includes renowned institutions, such as the Technicon in Haifa, Israel. These cooperations typically result in joint publications with significant contributions of the department team.	

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
The department is quite active in its scientific community. Apart from several invited lectures and awards, the department organized an international conference in 2019, followed by an international workshop in the same year.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
Within the evaluation period 2015-2019, the department head Dr. Michal Landa unexpectedly and sadly passed away in April 2018. Despite this huge impact, the team nevertheless managed to fulfil most of its planned research activities, accompanied by remarkable outputs, such that the research direction is in line with the perspective of the planned research directions	
D2.2	**Assessment of the previous research objectives and their achievement**
As stated above, most of the previously planned research objectives have been achieved with an excellent output quality and quantity.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
Two of the three recommendations from the past evaluation could be followed by a restructuring of the department and its laboratory. The recommendation to improve contract work and industry-oriented projects could not really be implemented, despite a medium and a few smaller contracts.	
D2.4	**Success in receiving grants**
The research of the department was supported by a total of 10 grant projects, mostly provided by the Czech Science Foundation.	
D2.5	**Adequacy of instrumental equipment**
The department has the capability to build own sophisticated laboratory equipment which otherwise would not be commercially available. Overall, the laboratory environment of the department is a competitive advantage.	
D2.6	**Effectiveness of management**
Even though not stated explicitly in the documents, the management of the department must be highly effective, as it does, compared by the number of full time equivalents workers, a large amount of productive high quality research.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The average age of the team is below 40, this count includes experienced researchers of the team, such that personnel stability seems to be guaranteed for the next years. In general, the department has difficulties to attract international researchers, which seems to be a general issue within Institutes of CAS, but implements counteracting measures such as international collaborations and exchange visits.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

The department mainly follows the HR strategy of its institute. The department consists of nearly 50% female team members and successfully manages personnel breaks due to maternity leaves and childcare.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.
N.A.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The department maintains an impressive number of cooperations on national and international level, leading to a large number of joint publications.	
D3.2	**Effectiveness of joint research centres**
The department is part of the research centre AdMat, comprising four institutes of CAS, the Czech Technical University and the Charles University, leading mainly to jointly supervised PhD theses and a share of experimental facilities.	
D3.3	**Success rate in supervision of PhD students**
Within the evaluation period, one PhD student defended her thesis while four others started a PhD project, supervised by department members.	
D3.4	**Participation of PhD students in the outputs**
During 2015-2019, the five PhD students of the department actively contributed to the publication of journal papers.	
D3.5	**Participation of the team in master or bachelor studies**
The department also supports theses on the master and bachelor level, leading to three completed master theses and one completed bachelor thesis.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Two members of the department regularly hold five different lectures at the Czech Technical University in Prague and the Charles University.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The department is not really active in the area of research popularisation. A few activities are due to the team member H. Seiner.	
D4.2	**Publishing activities and its quality**
In regard to outreach activities there are no notable activities.	
D4.3	**Participation in professional organisations in the area of research and development**
In view of professional research institution, department members show regular activities in view of journal reviewing, project reviewing, and co-chairing of international workshops.	

Other comments of the commission:
(None)

6. D6 – Electrical Engineering and Electrophysics

Strengths:
The department has a rather long history and can rely on good laboratory equipment and an experienced research team. There are close and long-lasting collaborations with a national energy company that lead on a regular basis to a good number of industrial, contracted projects.

Weaknesses:
The department's main focus is put on industrial collaborations within a traditional engineering field. Therefore, it is difficult to do actual fundamental research. Correspondingly, the publication rate is below average. In addition, it appears that the classical electrical engineering topics do not fit well into the department structure of the Institute of Thermodynamics. There is a shortage of younger researchers and a fragmentation of research topics into many small projects.

Opportunities:
Apart from the traditional electrical engineering and industry-oriented activities, more modern ideas emerge from the Laboratory of Electrophysics of the department, leading to a host of new research topics and applications that yet need to be established. This might also be attractive to more and foreign junior researchers.

Threats:
The fragmentation of the department might continue, due to diverging developments of the more traditional and more modern team activities. The traditional electrical engineering activities might become further isolated within the Institute of Thermodynamics and keep focus on national contract work. The age structure of the research team needs to be improved as well.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The department performs solid work, which is about average or a bit below. The quality level of selected outputs is below average with only a small portion of excellent contributions.	
H1.2	**Contribution of workers on the outputs reached**
About two thirds of the output has mainly be created by team members while about one third has been achieved with 50% contributions in collaborated research. That is, the main part of the contributions has been created by CAS team members.	
H1.3	**Quality of all outputs and results**
Most of the bibliographic output is distributed within the second, third, and fourth quartile, but there are two outputs in the excellent quartile as well. A considerable number of publications appears in journals without quality level. Overall, the quality is below average.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Within the traditional areas of electrical machines and drives, power electronics and power electronics the team produces solid work which is valuable for industry applications but not	

considered as groundbreaking. Activities within the Laboratory of Electrophysics contain many new ideas but still need to be established.

H1.5	Contribution of the participation of the authors in large collaborations
The department is involved in one large cooperation named „National Competence Centre - Cybernetics and Artificial Intelligence“	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
The research of the department is along the institute mission as it has a main focus on energy storage, energy distribution, and energy supply which is of utmost importance for modern societies.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
Due to the strong ties to the energy sector and industry, a knowledge transfer into practice certainly exists.	
H2.3	**Relation to practice**
The relation to practice is seen by a good number of contracted applied research projects.	
H2.4	**Participation in AV21 strategy**
The department participates in the AV21 strategy by the program „Efficient Energy Conversion and Storage“: 2017 High-power spark discharge generator for fine powder synthesis, 2018 Hydrogen fuel cell laboratory test stand, 2019 Catalyst layer deposition using SDG nanomaterials.	
H2.5	**Cooperation with regions of the Czech Republic**
The department collaborates closely with the national „Electrotechnika“ company and has also established recent contacts to a number of national research institutes, driven by the Laboratory of Electrophysics.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
As seen from the scientific output the team compares on an average level with respect to similar international and national institutes.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
International cooperations are moderate with some ties to Asian countries (Taiwan, Korea) to Slovakia, and to the U.S., these are not given by broad international cooperations. Well-	

established national cooperations with industry and newly established contacts to other national institutes exist.

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
Two team members are actively involved within their scientific communities while no conferences and workshops have been organized. Also, there have been neither awards nor invited lectures during the evaluation period.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	Direction in line with the perspective of the planned research directions
Among five planned key research topics, only one could not be pursued as planned, due to retirement of the corresponding key researcher and a lack of personal continuity. Remarkably, four new research topics have been created.	
D2.2	**Assessment of the previous research objectives and their achievement**
Overall, the expected goals have been achieved as the relevant projects produced a number of results that led to the aforementioned publications.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The problems with age structure and gender diversity could not be resolved, yet. The situation with a lack of foreign sources of funding could be slightly improved by the acquisition of one project.	
D2.4	**Success in receiving grants**
Unfortunately, the success rate of receiving grants is considerably below average. This is not the case, however, in view of contract work where the success rate is much better.	
D2.5	**Adequacy of instrumental equipment**
The department is well equipped with adequate laboratory instruments, as stated in their own presentation.	
D2.6	**Effectiveness of management**
The department is managed by an experienced team, which both maintains the good relations to industry but also is open to new research topics and ideas. Problems, such as difficulties in acquiring new researchers, might be out of the scope of responsibility of the department management.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
As already pointed out during the previous evaluation, the department has problems to maintain a healthy age structure and to attract new researcher, even though it forces to resolve these issued by an actively discussed HR policy.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

While an active HR policy exists, the problem of missing gender diversity could still not be resolved.

D2.9	Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.
N.A.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The department has collaborations with five national universities. International cooperations are given by several research exchange visits.	
D3.2	**Effectiveness of joint research centres**
The department is not really part of a joint research centres but could establish a cooperation with the Taiwanese Industrial Technology Research Institute (ITRI), due to a grant of CAS.	
D3.3	**Success rate in supervision of PhD students**
In the evaluation period 2015-2019, two PhD theses could successfully be completed.	
D3.4	**Participation of PhD students in the outputs**
The two successful PhD students contributed to publications in international magazines and presented their results at several conferences. They also continue as postdocs in the department.	
D3.5	**Participation of the team in master or bachelor studies**
Team members supervised one bachelor and one master thesis during the period 2015-2019.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The university teaching activities of the department are given by three lectures of two team members at the Czech Technical University in Prague that regularly are conducted.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
In general, the outreach activities of the department are rather basic and restricted to events organized CAS.	
D4.2	**Publishing activities and its quality**

Besides of two public lectures, no publishing activities related to outreach activities have been noted.	
D4.3	**Participation in professional organisations in the area of research and development**
No relevant participation has been noted.	

Other comments of the commission:
(None)

References of Part B:
[B1] 3-4_Report_on_the_research_activity_of_team.pdf
[B2] 3-5 Number_of_all_scientific_outputs.pdf (of Team)
[B3] Reports_of_the_I_phase_IT_1.pdf (of Team)
[B4] 3-3_Research_for_practice.pdf, provided by the administration
[B5] Handout of oral presentation slides of team

Final report was elaborated by:

Commission 7.1 - Engineering and technology
Evaluated teams No.: 1, 2, 3, 4, 5, 6

Commission Chair: János Lábár
Commission Deputy Chair: Jan Dusza
Commission Members:
- Tobias Bauer
- Frank Gronwald
- Stefan Haase
- Oliver Kastner
- Vladislav Musil
- Ryszard Pohorecki