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 Scientific Instruments of the CAS, v. v. i.

Evaluated teams and their leaders:

1. Electron Microscopy (Tomáš Radlička)
2. New Technologies (Martin Zobač)
3. Magnetic Resonance and Cryogenics (Zenon Starčuk)
4. Medical signals (Pavel Jurák)
5. Microphotonics (Pavel Zemánek)
6. Coherence Optics (Josef Lazar)

Part A: Evaluation of the institute

Strengths:
Competitive research and development on the international level in specific fields. High qualification of the teams, long-term experience in different research fields. Healthy age structure. Long-term and intense cooperation with universities, hospitals and industrial partners. Strong involvement in teaching activities.

Weaknesses:
The strategy for identifying new research trends and future topics could be improved. The majority of financial support comes from national sources. EU funding of some teams has room for improvement. Involvement of Master students at the Institute is relatively weak.

Opportunities:
Using existing experience in artificial intelligence of some teams and transfer this knowledge to other divisions for developing further topics at the Institute. Expansion of the activities of the Institute based on the success in research and development achieved so far. Tranfer success in basic research to potential applications in wider areas and in different fields.

Threats:
Over-expansion of the activities of the Institute without sustainable institutional support. Missing new research fields that are relevant for the Institute but are not at the focus of any of the current teams.

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

H1.1	Quality of selected outputs of Phase I
Word leading and internationally excellent outputs for several teams.	
H1.2	**Contribution of workers on the outputs reached**
Taking into consideration the number of research scientists (including PhD students) as well as of the published papers in journals with impact factor, in the evaluation period a ratio of 0.69 publications per researcher was calculated. This number seems to be low. However, it can be explained by the large number of industrial projects, which have a high societal impact.	
H1.3	**Quality of all outputs and results**
The Institute has demonstrated a significant increase in the number of outputs as well as in their quality. Compared to 2014, the Institute increased by approximately 50% the number of publications in journals with impact factor. In addition, the average impact factor of the publications increased from ≈2.5 to ≈4 since 2015 (+60 %). Furthermore, many of the last research works have been published in prestigious journals (such in Nature Photonics, Nature Communications, Advanced Science, Nano Letters, Advances in Optics and Photonics, Circulation Arrhythmia & Electrophysiology, Scientific Reports etc.). We appreciate the commitment to the San Francisco Declaration on Research Assessment and therefore do not put too much emphasis on journal-based metrics. Other relevant outputs are software and dissemination activities. An output area where not much was reported is research data in terms of published datasets. The Institute has also shown that it is capable of designing and constructing high-value equipment in different application fields, which is being used in relevant national and international projects. This is also reflected in the strong increase of the number of patents and utility models, from 3 to 15 (per year) in the evaluated period (2015-2019).	

H1.4	The most valuable discoveries and findings in the fields, their importance for the field
The most valuable discoveries and findings of the Institute are related to the same criterion for the specific teams. To avoid duplicity of the comments this is only stated for the Teams.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Not relevant.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
The Institute is a center of excellence for the Brno area and beyond, and it is in close cooperation with the local as well as international companies in the field. All teams contribute to the mission of CAS “to advance developments in scientific knowledge at the international level, while also taking into account the specific needs of both the Czech society and the national culture” as well as to the Institute’s mission “of examining the physical properties of matter”. The Institute strives to provide research-oriented services to the national and international community (e.g. the bio imaging platform).	
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**
The Institute is living the mission of CAS in the engineering field: “Top science in the interest of society“.	
H2.3	**Relation to practice**
The Institute shows a healthy balance between basic and applied research projects. The large number of industrial and applied research projects as well as clinical collaborations performed in the evaluation period demonstrate the strong contribution of the Institute to practice. In particular, the teams Coherence Optics, New Technologies and Medical Signals have been the most successful in this area.	
H2.4	**Participation in AV21 strategy**
ISI is the coordinator of one of the AV21 programs (Diagnostic Methods and Techniques). Applied Laboratories of ISI (ALISI) are an important basis of the instrumental infrastructure of the Institute. The number of projects related to AV21 increased from 15 to 23. The Institute also participated in other AV21 programs such as “Hopes and risks of the digital age, Efficient energy conversion and storage, New materials based on metals, ceramics and composites, Space for humanity and Light at the service of society“.	
H2.5	**Cooperation with regions of the Czech Republic**
Cooperation of the Institute with regions of the Czech Republic is well documented: ISI has participated in strategic commissions of the South-Moravian Region. The Institute is a founding member of the Czech Optical Cluster (with 26 members). The Institute has also contributed to the popularization of science and the development of education in the South Moravian Region through several participation in events as well as by organizing exhibitions for the general public.	

The Institute is a center of excellence for the Brno area. It is in close cooperation with the local companies in the field, which is of major importance for the area.

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

Several divisions within the Institute of Scientific Instruments are performing research at high quality levels. For example, the Team “New Technologies" is producing multilayer mirrors for X-ray radiation, which is unique in the Czech Republic and also not very common in the EU. The Team “Microphotonics” has an international reputation which is reflected, among others, by the journals where they have published many of their results (e.g. Transverse spin forces and non-equilibrium particle dynamics). The Team “Coherence Optics" is very well-known worldwide for the development of interferometers for several applications. The “Electron Microscopy” Team has unique experience in low-energy scanning electron microscopy. The “Magnetic Resonance” Team operates the Czech-BioImaging platform and is involved in the Euro-BioImaging consortium. The “Medical Signals” Team has successfully translated new diagnostic tools into clinical practice together with renowned international partners.

Challenging areas are for example the newly established research field of laser surface structuring with several known actors in the EU as well as Asia and USA. In addition, research in the field of electron-welding should be strengthened taking into consideration the new trends (e.g. artificial intelligence, in-line monitoring, green technologies). In these areas, we recommend developing a clear strategy of the topics to be addressed as well as to identify possible unique selling points.

With roughly 30% of institutional support, 30% of grants and 30% of industrial contracts, the Institute can be compared to Fraunhofer Institutes in Germany or TNO in The Netherlands. The overall composition of teams of the Institute seems to be unique in the research landscape.

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

The Institute has established several collaborations with international institutions from a large number of countries (Argentina, Austria, Italy, Germany, Greece, India, Mexico, UK, Switzerland, Turkey, Slovakia, USA, etc.) in the evaluation period. In total, ISI collaborates with more than 70 foreign academic institutions and more than 15 foreign industrial partners, which is impressive taking into consideration the size of the Institute. The improvement of the internationalization of the Institute is for example reflected by the increased number of European projects. Another indicator of the international character of the Institute is the share of publications in impacted journals that have been co-authored by collaborators outside the Czech Republic (40%). For the future, the Institute is encouraged to think about strategies to increase the number of international researchers hosted for a research stay. This will further strengthen the international network and reputation of the Institute. Measures could include incentives (e.g. institutional co-funding) for Teams hosting researchers.

At the national level, the Institute is collaborating at academic level, mainly with the Brno University and the University in Olomouc. Other collaborations are with the College of Polytechnics Jihlava, the Masaryk University and the Charles University. At the industrial level, strong interactions can also be seen, like Mesing, Meopta, Tescan Brno, API Optix,

Antonin, PSI, FEI Czech Republic, Thermo Fisher, etc. ISI operates a preclinical magnetic resonance unit, which is a part of the research infrastructure Czech-BioImaging.

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

The Institute has organized approximately 40 conferences and workshops, denoting the strong participation of ISE workers in the preparation and realization of these events. Some of them are the multidisciplinary conference LASER (from 2015-2018), the 1st International Workshop on Frontiers of X&XUV Optics and its Applications, International seminar of Microscopy and spectroscopy of surfaces and the International Workshop on Energy-Filtered Electron Microscopy.

Researchers from ISI have been recognized with 14 awards, showing the high quality and relevance of the activities performed. Several members have also given a large number of invited lectures. However, this is not common in all areas. A suggestion for increasing the visibility of the Institute is to organize symposia in the frame of already well recognized conferences around the world as well as to increase participation in relevant and prestigious events.

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

D2.1	Direction in line with the perspective of the planned research directions

The Institute has shown to be in line with the defined research strategy from the previous evaluation period.

D2.2	Assessment of the previous research objectives and their achievement

The Institute achieved the objectives defined in the previous period. Furthermore, the Institute was capable of establishing three new research groups, giving the chance to talented young investigators to establish their research lines, following the institutional strategy.

D2.3	Assessment of implementation of recommendations from past evaluation

In the previous evaluation period, ISI received a very good rating with minor comments and recommendations. We want to highlight that, in our opinion, the performance of the Institute has been improved further in both quality and quantity, especially by establishing several international activities.

D2.4	Success in receiving grants

Success in acquiring grants has been very high at national and international level. In this frame, the acquisition of eight European projects has to be mentioned, since they are very relevant for increasing the visibility of the Institute.

Although the Institute is very successful in acquiring grants from national and international sources, participation and the level of involvement in European projects has still room for further improvement in the future. Also, the Institute might consider supporting individual grant applications such as applications for ERC grants.

D2.5	Adequacy of instrumental equipment

The instrumental equipment is at top international level. However, since typical research grants cover mostly only personal costs, high-impact research activities requiring advanced instrumentation could become more difficult in the future. The development of a mid- to

long-term strategy for acquiring, operating, and maintaining new equipment should be considered.

We also comment on research software as part of the “instrumental equipment”. In-house software controls large parts of the experimental activities and is required to analyze and evaluate the acquired data as stated by the Institute. As such, research software has to be considered an essential asset and at least a basic strategy should be developed to ensure software quality and sustainability. This strategy should consider the different levels of use cases and software maturity as e.g. exemplified in the DLR software engineering guidelines: doi:10.5281/zenodo.1344611. Appropriate infrastructure in combination with training should be implemented at the Institute or Academy level if not already in place.

D2.6	**Effectiveness of management**

The Institute of Scientific Instruments increased the number of employees (full-time equivalent) from 162 to 192 in the period 2015-2019, representing an increase by 19%. This situation can be explained by the increased number of awarded grants as well as industrial projects. Simultaneously, the quality in research improved, demonstrating an effective management of the Institute structure and resources.

The Institute is applauded for having an Intellectual Property strategy, a contract support administration and project management support in place.

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

Courses for the qualification growth of superiors in soft skills are provided. Furthermore, language courses for all its employees are offered. Financial and non-financial bonuses were also implemented to motivate the institute employees.

HR policy is in place, however, it is difficult to attract PhD students due to the job market in the field and in the local area.

Even though the 8% international staff rate is an achievement considering that ISI is not located in the capital, the Institute is encouraged to identify further challenges for recruitment of international members and to work to overcome them. An idea for attracting international talent could for example be to reserve a share of the Institute’s budget to offer paid summer research internships to international undergraduate students. This might provide opportunities for the Teams to strengthen international collaboration and reputation as well as bring in new ideas from outside. The invited students might consider a career at ISI later based on a positive experience during their stay.

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

The age and gender structure is healthy overall but quite different between teams. The Institute management might want to closely monitor them and discuss with the individual team leaders.

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.**

The Application Labs (ALISI) funded originally by the National Programme are a core asset of ISI.

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
Strong cooperation with research institutions at national and international levels has been established. The collaborations are performed in the frame of joint research projects as well as in the form of exchanges.	
D3.2	**Effectiveness of joint research centres**
The Institute has established several collaborations in the form of joint research centres, including the “Centre of Excellence for Classical and Quantum Interactions in Nanoworld”, the “Competence Centre – Advanced Microscopy and Spectroscopy Platform for Research and Development in Nano and Microtechnologies”, the “National Competence Centre – Centre of Electron and Photonic Optics” and the “Interdisciplinary Collaboration in Metrology with Cold Quantum Objects and Fibre Networks” between others.	
D3.3	**Success rate in supervision of PhD students**
The number of PhD students increased from ≈23 to 30 between 2015 and 2019. In the same period, 16 PhD thesis were defended. Taking into consideration that in the research field of the Institute, completion of a PhD thesis requires 4.0 to 5.5 years, the success ratio is adequate. As there is quite a spread between groups and also extreme cases with much longer times required to complete a PhD, the management of the Institute might want to consider discussing a common frame.	
D3.4	**Participation of PhD students in the outputs**
PhD students participate in the outputs of the Institute by performing experiments, by writing scientific publications or by developing research equipment. PhD students have shown to be important in generating research results and participate actively in publication.	
D3.5	**Participation of the institute in master or bachelor studies**
The number of defended master and bachelor theses in the evaluation period was 2 and 37, respectively. The number of master students should be increased in the future. Such efforts should be seen as a measure to cope with the challenging workforce market and to attract good future researchers.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The number of semestrial lectures, seminars and courses given by Institute members is outstanding (more than 120). For instance, bachelor and master courses have been given at Brno University of Technology, the College of Polytechnics Jihlava and Masaryk University. Due to its specialisation, it is in some cases difficult to find university departments with similar interest. Nevertheless, particularly the teams with difficulties finding fresh talent are encouraged to intensify their activities in this area. If no local universities have programs with a fitting thematic scope, block courses at other national institutions could be considered.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
ISI has performed numerous activities with the aim of making its research more popular and accessible to the people. This includes the participation of the institute in the CAS' Week of Science and Technology, which is visited by ≈700 guests. The open day of the Institute should be highlighted. Several communication activities have been performed in the Czech TV and radio (26 and 27 contributions, respectively) as well as in newspapers and non-scientific journals. Also the efforts targeting high school students are highly appreciated.	
D4.2	**Publishing activities and its quality**
For most teams, publishing is not the prime objective. Nevertheless, a number of world leading and internationally excellent scientific outputs has been achieved by many of them. For dissemination to a wider audience, see D4.1	
D4.3	**Participation in professional organisations in the area of research and development**
Active participation in professional organisations is noted.	

Other comments of the commission:

The Commission has received a very positive impression of the Institute. The Institute is world leading or internationally excellent in several fields. It is well established in the Brno area. Its portfolio of research topics is very specific but addresses fields with considerable scientific and societal impact. It has increased its international cooperations substantially in recent years and was quite successful in acquiring research grants and industrial funds.

There is a large potential for expanding the research of the Institute, which is limited by the available man/female-power, and the institutional support of the Institute by CAS. The Institute is very dependent on grants and industrial contracts, which might pose a threat in the future. Specific recommendations further elaborated above include:

i) Developing and implementing internationalization and international visibility strategies,
ii) Strengthen participation in (and coordination of) European projects,
iii) Developing and implementing research data management policies and a research software strategy together with adequate infrastructure,
iv) Agile potential readjustment of activities in the electron-welding field,
v) Proactively monitoring the age and gender structure of the teams as well as time-to-completion for PhD students.

Concluding Remark: The Commission is aware of the fact that virtual site visits cannot replace person-to-person meetings. Nevertheless, based on the documentation provided and the virtual site visits, the Commission has made every effort to arrive at an objective and comprehensive Evaluation of the Institute.

Part B: Evaluation of teams

1. Electron Microscopy

Strengths:
Solid technical base, leader in cryo SEM. Collaboration with local SEM manufacturers and Japanese steel company. Numerous good publications. Diverse background of staff.

Weaknesses:
Most publications in Q3. The strategy for application of developed EM methods in other scientific fields could be clearer.

Opportunities:
New collaborations for detector technologies. Ion beam technologies.

Threats:
Considering the high share of third-party funding (particularly from local industry), a threat is potential breakdown of this funding if industry cuts research budgets or relocates local R&D efforts. Strong links to local EM manufacturers might be weakened if they relocate.

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

H1.1	Quality of selected outputs of Phase I
Of the selected outputs, 9 were in category 1* and 13 in 1, which is excellent.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the reached outputs is comparable to international level.	
H1.3	**Quality of all outputs and results**
The Team publishes solid work in renowned journals. 22 Q1 publications in 5 years by 23 FTEs. Overall, the Team publishes 1.1 publications / FTE / year, which is in the higher range. However, most of the publications were rated in Q3, which shows room for improvement for the future.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The Team made substantial progress and moved the field forward e.g. in the areas of low-energy electron assessment of advanced 2D materials and super low energy scanning electron microscopy.	
H1.5	**Contribution of the participation of the authors in large collaborations**
The Team participates in the “Center of electron and photonic optics” (CEPO), the European MSCA-ITN SIMDALEE2, and the industrial 0eV project.	

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 contributed to the mission of the CAS “to advance developments in scientific knowledge at the international level, while also taking into account the specific needs of both the Czech society and the national culture” as well as to the Institute’s mission “of examining the physical properties of matter”.	
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**
Translation into practical application is exemplified by the close collaboration in the fields of steel and life sciences.	
H2.3	**Relation to practice**
See Institute report.	
H2.4	**Participation in AV21 strategy**
See Institute report.	
H2.5	**Cooperation with regions of the Czech Republic**
See Institute report.	

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
Electron microscopy is an active research field with many groups world wide. The overall research portfolio of the Team is unique, though.	
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 is involved in several academic and industrial collaborations at high level.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Members of the Team served on several boards, organized numerous workshops and gave invited lectures. We want to emphasize that awards were won by several team members.	

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

D2.1	Direction in line with the perspective of the planned research directions
The Team plans to evolve the existing research lines as detailed in the report. These are mainly methodological progress projects, which is important to stay competitive and continue the strong basis of the Team. Aspects that are less clear are concrete future plans of applying the methods to solve problems in the application domains, which could increase societal impact as well as publication output.	
D2.2	**Assessment of the previous research objectives and their achievement**
The Team mostly fulfilled the objectives and did a lot of applied work. In some areas, the plans were adapted after initial results, which shows that the Team is flexible and agile.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The (rather unspecific) recommendations were fully implemented.	
D2.4	**Success in receiving grants**
The Team is mostly third-party funded, which underlines the succes in receiving grants.	
D2.5	**Adequacy of instrumental equipment**
The new equipment acquired during the evaluated period exceeded the plans of the Team.	
D2.6	**Effectiveness of management**
The Team is composed of 6 groups, which is a comparatively high number. Nevertheless, the Team as a whole is productive and seems to be managed well.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The Team benefits from the diverse background of its members. The heads of the 6 groups seem to be on non-permanent contracts, which could be a threat for the future. Healthy age structure.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
See Institute report.	
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.**
See Institute report.	

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
Numerous and intense collaborations with renowned centers (USA, Austria, Switzerland, UK, Japan, Finland, Greece, The Netherlands, Singapore).	
D3.2	**Effectiveness of joint research centres**

Not applicable.	
D3.3	**Success rate in supervision of PhD students**
13 PhD students were supervised in the evaluated period, and only 2 defended. Considering the high number of groups within the Team, a joint frame of support for PhD students sould be considered (in the Team or on the Institute level).	
D3.4	**Participation of PhD students in the outputs**
Several publications with PhD students as first author.	
D3.5	**Participation of the team in master or bachelor studies**
6 theses. This is <1 thesis per 10 FTE years and the Team should increase its efforts to attract more students.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several lectures at 3 universities. This comparatively high level of involvement is applauded and will likely pay off.	

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

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Diverse and numerous as detailed in the documentation.	
D4.2	**Publishing activities and its quality**
See D4.1	
D4.3	**Participation in professional organisations in the area of research and development**
Wide range of involvement in evaluation panels, scientific societies, politics councils, advisory boards.	

Other comments of the commission:

The impression of the Commision regarding the Team “Electron Microscopy” is very positive. We recommend to i) work on further increasing the quality of the outputs (mostly Q3 currently), ii) develop a medium-term strategy for the portfolio of groups considering that their heads are mostly in non-permanent positions, iii) focus on completion of PhD studies within a reasonable time frame.

2. New Technologies

Strengths:

Diversity of research areas. Strong connection with industry.

Weaknesses:

Low participation in European Projects. Unclear vision for new research topics in the future. Name of the Team should be reconsidered to increase visibility, considering that the methods are not really new. “Vacuum technologies” (or similar) could be an option.

Opportunities:

Incorporation of new strategies (e.g. artificial intelligence, self-learning, monitoring concepts) in existing methods.

Threats:

Ageing of research areas if new challenges are not considered.

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

H1.1	Quality of selected outputs of Phase I
Most of the outputs are related to optical technologies followed by nanoscience, material science and applied physics. The evaluated outputs (in total 10) belonged mainly to the 2-4 quartiles, denoting good to moderate quality. The outputs also were evaluated to belong mainly to 2-4 quality groups, which means that they are recognized internationally in general, in terms of originality, significance and rigour, and/or result of recognisable novelty with actual or likely future innovative potential.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the reached outputs is comparable to international level.	
H1.3	**Quality of all outputs and results**
The Team is addressing complex and relevant technological processes, which are today of significant importance in different technological sectors, such in laser processing (large-size microstructure diffractive optical elements) as well as X-ray optics (multi-layered systems). In addition, joining technologies based on electron-beam processing for a diverse materials represents an important research area of the Team. Furthermore, some of the performed projects address very challenging objectives, such as the ExoMars 2022 mission which main aim is to search for signs of past life on Mars. In summary, the quality of the evaluated outputs and results is high.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Within the most valuable findings, just a few are mentioned here: (i) Design and manufacturing of a spring-powered self-erecting rod antenna for the detector of electric field for ExoMars mission, being of high relevance in space exploration; (ii) Fabrication of diffractive optically variable image devices (DOVID), being important for counterfeiting applications; (iii) Manufacturing of multilayer mirrors for the X-ray and extreme ultraviolet	

spectral domains, related to a field requiring high quality coatings; and (iv) Strong activities in the field of metal joining, what is relevant for the local industry.

H1.5	Contribution of the participation of the authors in large collaborations
There have not been large collaborations in the reported period. However, this is not relevant for the development of the Team.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
The “New Technology” Team is strongly supporting different industrial actors, which is visible due to the very large amount of performed industrial projects (450 projects of contract research). Thus, they are clearly supporting the private sector, having an important 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**
The Team showed an important number of performed industrial projects (applied research) denoting the transfer of knowledge to practice.	
H2.3	**Relation to practice**
See H2.3.	
H2.4	**Participation in AV21 strategy**
The Team was involved in the AV21 strategy, such as the ExoMars mission (supported by AV21 programme 28). An international workshop on frontiers of X & XUV optics and its applications was co-funded by the AV21 strategy program.	
H2.5	**Cooperation with regions of the Czech Republic**
The Team is strongly cooperating with regions of the Czech Republic, mainly in the sectors automotive, nuclear research, heavy machinery, and aviation.	

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 quality of the work performed by the Team is recognized internationally. Some of the research topics can be classified as world leading.	
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 is interacting with several national and international partners (mainly in the industrial sector).	

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
In the evaluated period (2015-2019), only one workshop and one seminar were organized. This performance is quite poor. The amount of invited lectures was also very low (only three) taking into consideration the amount of researchers and the duration of the evaluated period. However, the number of conference participations significantly increased (from 15 to 47) compared the previous evaluation period. The Team also received one award.	

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

D2.1	Direction in line with the perspective of the planned research directions
The strengths of the Team are related to significant cooperation with industrial partners, based on funded projects or by contracts coming directly from industry. In this frame, the team strategy is based on following the industrial demands for establishing their research topics. However, the “New Technologies" Team should evaluate which will be the “technologies” that could be relevant in the future, or incorporating new concepts (e.g. artificial intelligence, self-learning algorithms) for improving manufacturing systems as well as being in-line with future topics which are not only relevant for the Czech Republic but also for the European Union.	
D2.2	**Assessment of the previous research objectives and their achievement**
The Team has shown to be capable to assess the research objectives defined in the previous period.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The Team has addressed and implemented several of the recommendations from the past evaluation. For example, the scientific output of the Team has been improved (e.g. 47 conference papers compared to 15). The Team has also adopted some research topics in relevant areas. Few areas have been omitted (e.g. biology or medicine).	
D2.4	**Success in receiving grants**
The Team has shown to be successful in acquiring funding, through different agencies (e.g. MITCR) as well as by direct acquisition from industry (~180 k€/year). Important to mention is the cooperation with the European Space Agency. In the future, the Team should also explore other funding sources, such as different programs from the European Union. The Team started an ERANET project at EU level, showing an improvement in this evaluation category.	
D2.5	**Adequacy of instrumental equipment**
The equipment and devices are at top international level.	
D2.6	**Effectiveness of management**
Taking into consideration the large among of performed projects (many small projects, requiring high administrative affords), the significant amount of different topics as well as the small size of the Team, the management can be considered to be very effective.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**

The age structure of the Team is mainly distributed between 30 to 55 years. Recruitment efforts for younger scientists should be implemented. The Team has acquired in 2020 two new PhD students, denoting the efforts performed to improve the age structure of the Team. The development strategy of the Team follows the Institute plan.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues
The strategy of the Team is in accordance with the Institute development plan.	
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.**
Not relevant for the further development of the Team.	

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
At national level, the Team has shown to cooperate mainly with the Brno University of Technology. At international level, a Memorandum of Cooperation was signed with the University in Mu'tah, Al-Karak (Jordan). Some additional activities were also reported with the "Ostbayerische Technische Hochschule Regensburg".	
D3.2	**Effectiveness of joint research centres**
The Team was not involved in any joint research centre.	
D3.3	**Success rate in supervision of PhD students**
The Team reported to have problems in the acquisition of new PhD students in the evaluation period. This situation improved in 2020.	
D3.4	**Participation of PhD students in the outputs**
The participation of PhD students in the Team is relatively low (< 10 %). One PhD thesis was successfully defended in the evaluation period. This situation should be improved in the future.	
D3.5	**Participation of the team in master or bachelor studies**
The participation of the Team in master or bachelor studies was moderate (1 bachelor and 3 master thesis defended). The Team has expressed difficulties in acquiring young students, although the Team members are offering several courses at university partners.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Teaching activities were satisfactory (Brno University of Technology).	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation

The Team “New Technologies” has addressed different activities with the aim of making their research more popular. This includes their participation in the CAS’ Week of Science and Technology, where two areas were presented; hosting several excursions to laboratories (e.g. from universities in Brno); the realization of dissemination talks in the frame of the “Svedu vědu” platform. The Team participated also at different exhibitions in the Czech Republic (e.g. PVA EXPO Prague).	
D4.2	**Publishing activities and its quality**
The Team has implemented some publications for the general public as well as a white paper. For dissemination to a wider audience, see D4.1	
D4.3	**Participation in professional organisations in the area of research and development**
The Team members have participated in different professional organizations, such the Czech Committee PRODEX, scientific committee of conference iSYDMA 4 and the organizing committee of Electron Beam Technologies conference (Bulgaria).	

Other comments of the commission:

The impression of the Commission regarding the Team “New Technologies” is very positive. As a minor recommendation, the Team is suggested to increase its international visibility by organizing symposia at already established international conferences, or by being included as committee members in the organization of relevant conferences. Also renaming the group might facilitate establishing higher visibility.

3. Magnetic Resonance and Cryogenics

Strengths:
Established imaging platforms, synergy with animal experiments, mix of methods & application.

Weaknesses:
No tight interconnection between magnetic resonance and cryogenics groups as apparent from completely separate reporting. As discussed at the virtual side visit, this side-by-side research does not cause any friction or organizational overhead, though. No PhD students in cryogenics group.

Opportunities:
Application of developed methods to wide range of problems.

Threats:
Falling below the 'critical mass' if persons or funding break away. Technician (average!) age is 68.7 years. There is a risk of losing critical knowhow and experience.
Cryogenics group seems to rely substantially on its history and tradition.

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

H1.1	Quality of selected outputs of Phase I
The selected outputs show a good quartile distribution and above average ratings. The group has more top publications than top citations, which could indicate that it might want to put more emphasis on disseminating/advertising its studies within the scientific community through conference participation, consortium involvement and social media.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the reached outputs is comparable to international level.	
H1.3	**Quality of all outputs and results**
Further Q1 and Q1* outputs that were not selected for phase I indicate the large number of high quality outputs.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Perfusion imaging: Functional changes in schizophrenia precede structural changes Turbulent fluids: Experiments stimulating discussion about theoretical results	
H1.5	**Contribution of the participation of the authors in large collaborations**
The Team participates in the Czech-BioImaging, COMPASS at CERN, EuHIT collaborations.	

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 is relevant for society due to the high translational potential of perfusion imaging for both the cardiology and the neurology field as well as advancing MR methods in general.	
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 Team has several collaborations with companies and other research teams. It is a busy hub for animal research providing service for the national research community. Translational science projects are ongoing with the Med Uni Wien.	
H2.3	**Relation to practice**
The Team provides MR services to the community as well as animal research. Their jMRUI is licensed to 5000 users. It is not open source and should not be advertised as such. The plans to open it are highly welcome and we encourage the Team to pursue them as this also puts the community in a position to contribute to the maintenance and further development of the software and therefore increases sustainability.	
H2.4	**Participation in AV21 strategy**
See Institute report.	
H2.5	**Cooperation with regions of the Czech Republic**
See Institute report.	

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
Both groups in the Team have international competitors working on similar topics. The groups' research is competitive.	
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 is involved in several academic and translational collaborations, namely the jMRUI software consortium, the European Horizon 2020 MSCA-ITN INSPiRE-MED, and a project with Med Uni Wien.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The team members participate in scientific community activities at a reasonable level.	

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

D2.1	Direction in line with the perspective of the planned research directions
The MR group mainly plans to utilize previously developed methods in the medical field, which is a reasonable plan considering the significant potential of their methods. In the meantime, also methodological work should be performed in parallel to stay competitive and on top of the field. To increase their capacity, the group could consider coordinating a European project. The software activities are timely and of strategic importance. Making the software open source and building a vivid user and developer community around it will help to further strengthen the group's position in the scientific community. The cryogenics group's research plans are mostly defined by participation in funded projects. The successful acquisition of these projects underlines the quality and timeliness of these topics.	
D2.2	**Assessment of the previous research objectives and their achievement**
The Team reports about good progress in the last period even though it did not become entirely clear from the documentation which objectives were previously set.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The MR group tried hard to implement the recommendations. The number of FTE has increased but likely not sufficiently. It appears that more sustained funding is required for the Czech-BioImaging or the legal issues need to be solved that prevents the group from charging for their services (see D2.6). Cryogenics: no specific recommendations addressed.	
D2.4	**Success in receiving grants**
The Team was successful in acquiring several competitive projects (including European ones).	
D2.5	**Adequacy of instrumental equipment**
The equipment and devices are at competitive levels.	
D2.6	**Effectiveness of management**
The Team outlined that they cannot do imaging as a paid service. For this, the statute of the Institute would need to change apparently. Considering that 30% of the group's budget could be funded through such revenues potentially, the Team should explore options to make this happen. If the statute of the Institute cannot be changed or should not be changed, other options might be e.g. an associated service unit as a spin-off.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The Team shows a good gender balance and a comparatively high international PhD student share (partly due to MSCA ITN rules). The age structure of the cryogenics group calls for action to prevent loss of crucial knowledge and expertise. Moreover, the fact that no PhD students were supervised in the cryogenics group should be addressed in the future to bring in new ideas. Currently, the Team seems to benefit a lot from (and rely on?) previous achievements and its history.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
See Institute report.	

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.
See Institute report.	

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
Through its involvement in the MSCA-ITN, the Team has close collaboration with several European universities and industry partners. Moreover, there are bilateral collaborations with Med Uni Wien and University of Bergen, University of Utah, Charles University, Yale University, TU Ilmenau and others.	
D3.2	**Effectiveness of joint research centres**
Not applicable.	
D3.3	**Success rate in supervision of PhD students**
Good level of involvement. 4 PhD students defended, 9 supervised.	
D3.4	**Participation of PhD students in the outputs**
In the MR group, PhD students contributed a fair amount to outputs. As there were no PhD students in the cryogenics group, the participation to outputs is naturally poor.	
D3.5	**Participation of the team in master or bachelor studies**
MR: 2 Bachelor + 7 Master theses defended Cryogenics: 4 Bachelor + 1 Master theses defended; Overall, 14 theses were supervised during 5 years by 20 scientific employees, which relates to 0.15 theses / person / year. The groups should aim to increase this number as student projects are cheap and effective ways to bring in new ideas, get projects done and also attract new talent to the Team.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
7 people taught courses at 2 universities.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The cryogenics group presented a good variety and high number of outreach activities. The MR group only participated in the ISI Open Day. While it is reported that “attractive presentation is not easy”, we think there should be numerous opportunities for outreach also in this field. In the long-term, this could also contribute to solving the limited workforce problem to some extent by attracting good students.The group is encouraged to think about alternative ways of presenting their research to a wider audience.	

D4.2	Publishing activities and its quality
For dissemination to a wider audience, see D4.1.	
D4.3	**Participation in professional organisations in the area of research and development**
Good range of involvement in evaluation panels, scientific societies, politics councils, advisory boards. More international involvement might help to further strengthen the groups‘ position in the research community and make their results better known.	

Other comments of the commission:

The impression of the Commission regarding the Team “Magnetic Resonance and Cryogenics” is very positive. We recommend i) increasing the visibility of the groups in the international community by putting emphasis on disseminating/advertising their studies within the scientific community through conference participation, consortium involvement or social media, ii) exploring options to generate revenue through imaging services provided to the research community, iii) counteracting the risk of losing technician knowhow through retirement, iv) considering to turn the proprietary software into open source, v) increasing the involvement of PhD students as well as Bachelor and Master students, who could be attracted by research-oriented teaching activities of the team members.

4. Medical signals

Strengths:
Strong international collaborations; focus on 2 organ systems; focus on ultra high frequency signals.

Weaknesses:
No strong links with other groups in ISI. Medical signals does not fit naturally in the theme of the Institute “Physical Properties of Matter”.

Opportunities:
Support other teams within ISI in their machine learning endeavours. Further collaboration with clinical partners to translate the recently developed methods to benefit patients.

Threats:
How much more applications are there for UHF signals? What will be the next methodological project for the Team?

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

H1.1	Quality of selected outputs of Phase I
The Team reported 4 Q1 publications in 5 years by 8.3 FTEs. Most of the outputs were in the category n/a and the highest number in ranked outputs was in Q3 and Q4. The Team is encouraged to work on increasing the average quality of their outputs.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the reached outputs is comparable to international level.	
H1.3	**Quality of all outputs and results**
Solid work in very well established journals. A particular success is that the Team published their work in clinical journals with a medical readership, which underlines the translational relevance and impact on clinical routine.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The most valuable discoveries and findings of the Medical Signals Team are in the fields of Ultra High Frequency ECG, Ventricular Dyssynchrony Imaging, and ultra fast ripples in the brain.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Not applicable.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
As detailed in H1.3, the results and outputs of the Team are of high societal relevance. The fit with the mission of the Institute (“Physical Properties of Matter”) is less clear.	

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
Two outstanding examples of transfer into practise are the clinical translation of the ventricular dyssynchrony imaging technology developed by the Team. The other one is the SignalPlant software for which the Team also organized user meetings and training workshops. However, the software does not seem to be open source, at least neither the code could be found on the webpage nor was there a link to a source code version control repository.	
H2.3	**Relation to practice**
See Institute report.	
H2.4	**Participation in AV21 strategy**
See Institute report.	
H2.5	**Cooperation with regions of the Czech Republic**
See Institute report.	

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 Team performs high quality research in the very active field of biomedical engineering in the cardiology and neurology realms. There are numerous other groups working on similar topics. The Team is competitive and seems to have found its niche focused on ultra high frequency signals for the near future. In the long run, this niche might need to be refined or expanded to stay innovative.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
Cooperation with leading clinical centres in the VDI project. Czech, European and internationally.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The Team has comparatively little involvement in conference committees and in editorial work. They organized workshop series and a conference. The team members gave several invited lectures and their work was recognized by several renowned awards.	

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

D2.1	Direction in line with the perspective of the planned research directions
The research program presented is topical and timely even though the description is not very specific. A potential weakness are the rather marginal links with other groups in ISI.	

The main focus is utilization of previously developed methods and their clinical translation, which is a reasonable and natural choice considering the current state and recent successes of the research projects. In parallel, the Team should work on methodological improvements and look out for emerging fields and methods to potentially adjust its portfolio. 8 projects for 8 FTEs are quite ambitious.
D2.2 **Assessment of the previous research objectives and their achievement**
The Team reports about good progress in the last period even though it did not become entirely clear from the documentation which objectives were previously set.
D2.3 **Assessment of implementation of recommendations from past evaluation**
See D2.3.
D2.4 **Success in receiving grants**
The Team received a total of 1.1 million Euro of third-party funds with the biggest project being 335k€ for the VDI monitor. The sum of third-party funds per FTE is lower than in the other teams in the Institute.
D2.5 **Adequacy of instrumental equipment**
The hardware equipment seems to be adequate. Considering the central role that software plays in the team's research, the Team is encouraged to develop and implement software sustainability approaches and software quality measures. Research Software Engineers will be essential members of the Team.
D2.6 **Effectiveness of management**
The Team has a new structure with 2 groups. They have methodological overlap but work on different application fields (cardiology/neurology). Apparently, this structure works well and is effective.
D2.7 **Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The Team's research is centred around two group leaders. The management should develop a long-term strategy and perspective considering that these group leaders are employed on non-permanent contracts.
D2.8 **Creating work-life balance conditions, assessment of approach towards possible gender issues**
The documentation identifies the fact that the Team comprises only male members as a weakness. This is to a certain level remedied by female collaborators but also the Team itself would likely benefit from a more diverse composition. Unfortunately, there are no strategies in place to attract female and international talent.
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.**
See Institute report.

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 strong collaborations with several renowned research institutions is a highlight of the Team's research profile.	
D3.2	**Effectiveness of joint research centres**
Not applicable.	
D3.3	**Success rate in supervision of PhD students**
4 of 7 PhD students defended their thesis. The fact that some PhD projects are running since 2012/2014 needs to be addressed.	
D3.4	**Participation of PhD students in the outputs**
While there are considerable contributions of PhD students, there are unfortunately no first author outputs by PhD students in the selected outputs.	
D3.5	**Participation of the team in master or bachelor studies**
The Team supervised 34 student projects, which is almost 1 thesis / FTE / year. This comparatively high level of involvement is applauded and will likely pay off.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The Team taught 11 courses at 2 universities. This comparatively high level of involvement is applauded and will likely pay off.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The Team is very active in disseminating their research to the general public and specialized audiences and uses a wide range of communication channels.	
D4.2	**Publishing activities and its quality**
For dissemination to a wider audience, see D4.1	
D4.3	**Participation in professional organisations in the area of research and development**
Good range of involvement in evaluation panels, scientific societies, politics councils, advisory boards. More international involvement might help to further strengthen the group's position in the research community and make their results better known.	

Other comments of the commission:

The impression of the Commision regarding the Team “Medical Signals” is very positive. We recommend i) increasing the visibility of the groups in the international community by putting emphasis on disseminating/advertising their studies within the scientific community through conference participation, consortium involvement or social media. Other measures in this respect can comprise editorial and committee work in the international scientific community. ii) Increasing the level of third-party funding, potentially through involvement in international consortia but also considering individual grants (e.g. ERC). iii) Develop and implement software sustainability approaches. iv) Develop a long-term strategy and perspective for the Team considering that the two group leaders are employed on non-permanent contracts. v) Develop and implement strategies to attract female and international talent. vi) Focus on completion of PhD studies within a reasonable time frame.

5. Microphotonics

Strengths:

Scientific output; scientific reputation; international cooperation.

Weaknesses:

Relative low funds generated by cooperation with the private sector.

Opportunities:

Increasing the amount of applied research; creation of spin-offs; chances of acquiring relevant international grants (e.g. ERC).

Threats:

None.

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

H1.1	Quality of selected outputs of Phase I
Most of the outputs are related to optics followed by applied science and instruments/ instrumentation. The evaluated outputs (in total 23) belonged mainly to the 1*-2 quartiles, denoting an extraordinary level. The outputs were also evaluated to belong mainly to the quality groups 1 to 3, which means that the quality of the performed work was world-leading, internationally excellent or recognized internationally in terms of originality, significance and rigour, and/or result of recognisable novelty with actual or likely future innovative potential.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the reached outputs is comparable to international level.	
H1.3	**Quality of all outputs and results**
The Team is performing outstanding research in different photonic fields, such as optical micromanipulation using spatially shaped laser beams, non-linear stochastic systems, imaging and diagnostic methods (e.g. for medicine, microbiology) and finally the design of custom-made experimental setups. The quality indicators for the Team denote a high level of research, showing also an important diversity within the mentioned areas. The Team has also been able in the evaluation period to publish at least three publications in nature journals as well as several high-quality ranked journals (opt. express, nano letters, phys. rev. A). In summary, the quality of the evaluated outputs and results can be rated as outstanding.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
There are several findings and results presented by the “Microphotonics" Team that can be described as outstanding. In particular, the measurements of optical momentum and transverse spin-dependent force using a nano-cantilever, the holographic optical manipulation through soft-glass multimode fibre as well as transverse spin forces and non-	

equilibrium particle dynamics in a circularly polarized vacuum optical trap are very relevant for the research field.

H1.5	Contribution of the participation of the authors in large collaborations
There have not been large collaborations in the reported period. However, this aspect is irrelevant for the further development of the Team.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
For this Team, there are some topics that could have an important societal relevance, in particular for the relation with diseases (characterization of living organisms).	

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 Team has developed some devices that are today offered by national companies. Some of these devices have been licensed. The Team denoted difficulties in the direct commercialization of these devices, since for example research institutes cannot fulfil legal requirements that are standards when commercializing products (e.g. warranty).	

H2.3	Relation to practice
Relation to practical examples for the research performed by the Team “Microphotonics” can be considered as challenging due to the advanced level of the investigated topics. However, the Team was able to transfer some developments to the industry and has constructed devices that are used by other labs worldwide.	

H2.4	Participation in AV21 strategy
See Institute report.	

H2.5	Cooperation with regions of the Czech Republic
At national level, the Team has strong cooperation with different players in the field including Palacky University (Olomouc), Brno University of Technology, St. Anne's University Hospital and Loschmidt Laboratories of the Masaryk University, Photon Systems Instruments and IQ Structures among others.	

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
Taking into consideration the size of the Team, its scientific productivity and the reputation of the investigators, the “Microphotonic” Team performs high-quality research and can be considered as a world-leading group.	

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 cooperates intensely with several international institutions of several countries (Argentina, Italy, Germany, Mexico, UK, Turkey, Slovakia, etc.). Some of these cooperations are related to joint projects while others are informal. Clearly, the Team has shown a strong engagement to initiate (and maintain) cooperation with international partners.

D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The Team has organized several conferences and international workshops (including several schools). It has also been awarded with three prizes (one in Japan) and has presented more than 40 invited lectures, which shows the high quality of the performed work.	

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

D2.1	**Direction in line with the perspective of the planned research directions**
The performed research tasks are in line with the planned research in the area of different photonic fields, such as optical micromanipulation, non-linear stochastic systems, imaging and diagnostic methods. Furthermore, activities in the field of biological and biomedical applications were increased.	
D2.2	**Assessment of the previous research objectives and their achievement**
Objectives have been reached by the Team. Furthermore, the Team could recruit two new team leaders.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
Since the past evaluation has been very positive, the Team continued performing research activities following the initial plan. The success of the Team can be also seen by the important increase of the number of Team members (from ~ 18 in 2015 to ~31 in 2019).	
D2.4	**Success in receiving grants**
The Team has been very successful in acquiring national grants, which has allowed it to almost double the Team's size. Efforts on acquiring relevant international grants (e.g. ERC, EU funding) could be increased, since some of the Team members have the potential for addressing this challenge.	
D2.5	**Adequacy of instrumental equipment**
The equipment and devices are at international level.	
D2.6	**Effectiveness of management**
Management of large teams requires additional efforts. For assuring the performance of the Team, the Institute should evaluate the possibility of financing one position regarding management of projects. However, this situation (high bureaucracy and time-consuming management) is common, at least in the EU.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
Management of large teams requires additional efforts. In this frame, the definition of two groups within this Team will permit a better management of activities. Taken into consideration the large amount of projects, the management can be considered to be very effective.	

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues
The strategy of the Team is in accordance with the Institute development plan. The structure of the Team is multidisciplinary (including physicists, experts in engineering, chemists, biologists and a veterinary doctor) with 10% of foreign members and ~33% of women (which is quite high considering the average in physics and engineering).	
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.**
Not relevant for the further development of the Team.	

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 cooperation with universities at national and international level is outstanding. The Team has established scientific collaborations for instance with the CNR-IPCF (Italy), the Leibniz Institute of Photonic Technology (Germany), Universidad Nacional Autónoma de México, the CONICET (Argentina), University of Edinburgh, University of Oxford, etc. At the national level, the “microphotonics" Team is cooperating with Palacky University, Brno University of Technology and Masaryk University.	
D3.2	**Effectiveness of joint research centres**
The Team has established numerous involvements with research centres. This includes the “Center of excellence for classical and quantum interactions in nanoworld“ and the “National Centre of Electron and Photon optics“.	
D3.3	**Success rate in supervision of PhD students**
In the evaluated period, 2 PhD thesis (supervised by the team members) were successfully defended.	
D3.4	**Participation of PhD students in the outputs**
The number of PhD students within the Team increased from ~ 4 to 8 in the evaluation period. The PhD students contributed to the team outputs in form of scientific publications, and were also involved in different research projects.	
D3.5	**Participation of the team in master or bachelor studies**
Bachelor and Master students involved in the team activities have successfully defended in total 6 theses. Taking into consideration the size of the Team, this number could be increased in the future.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The team members are offering several lectures, seminars and courses to bachelor and master students (4 and 12, respectively). This is extremely important for recruiting young investigators to the Team in the future.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Outreach activities have been performed in several manners. The Team shows to have a clear understanding of the importance of popularization of their research topics. Activities include several participation in TV, radio and Newspapers, as well as public lectures, talks and demonstrations. The team activities are very well documented at the group's homepage.	
D4.2	**Publishing activities and its quality**
For dissemination to a wider audience, see D4.1.	
D4.3	**Participation in professional organisations in the area of research and development**
Several members of the Team have activities in professional organizations, related to the evaluation of research proposals, reviewing publications or have been members of doctoral thesis committees.	

Other comments of the commission:

The impression of the Commision regarding the Team "Microphotonics" is very positive. It has been able to perform research at the highest international level. The topics of the Team are today very relevant and will allow it to acquiere further international grants. The Team could increase its international visibility by placing symposia at already well established international conferences.

6. Coherence Optics

Strengths:

Covering of a wide variety of research topics, assuring long-term funding. Cooperation within the European Union as well as with regional institutions and enterprises. Strong engagement in public activities.

Weaknesses:

Activities of the Team in the area of laser technology are not very well known internationally. Relative low participation in recognized international conferences.

Opportunities:

Using existing experience from other groups at ISI in artificial intelligence for the further development of research topics in the area of laser technologies.

Threats:

Joining technologies could become state of the art in the future. Additional innovative topics should be identified.

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

H1.1	Quality of selected outputs of Phase I
Most of the outputs are related to optics followed by applied sciences and instruments/ instrumentation. The evaluated outputs (in total 22) belonged mainly to the n.a. quartile (decile). However, this may be related by a wrong classification of the outputs in Phase I. We recommend CAS to review this point. The outputs also were evaluated to belong mainly to the quality group 3, which means that they are recognized as acceptable in terms of originality, significance and rigor, or that the results represent an improvement with potential to contribute to society or economy. However, as mentioned before, this is probably affected by the not adequate classification of outputs during Phase I. From the point of view of the Commission, the Team is making outstanding contributions in both basic and applied research.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of workers on the outputs is comparable to the international level.	
H1.3	**Quality of all outputs and results**
The department of Coherence Optics is performing activities mainly in the areas of fundamental optical metrology and laser technologies. Within the group “coherent lasers and interferometry”, important results with a high quality have been reached, for instance in the area of quantum metrology. In the area of “laser technologies”, the Team has also shown high-quality results, for example related to fundamentals of laser welding and the implementation of monitoring concepts and welding strategies (e.g. scanner and wobbling welding). The Team has also applied for 23 patents/utility models. In summary, the quality of the evaluated outputs and results is high.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**

The results obtained in the field of quantum metrology (using laser-cooled Calcium ions) are outstanding, and represent a very important research field in this decade. Within the performed activities, DCO scientists have developed specialized electronics and a data server that allows remote management and archiving of all signals in real-time. The compact multi-pass cell designs, developed for the TEXUS 54 mission are also worth to be mentioned as well as the fibre Bragg Grating strain system for a nuclear power plant in CZ. The new concepts developed for laser welding are also very innovative.

H1.5	Contribution of the participation of the authors in large collaborations
There have not been large collaborations in the reported period. However, the Team has strongly participated in different international projects.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Several outputs of the Team are related to strategic partnerships with high-tech companies, which are finally implemented in products or services that can have a significant 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**
Some members of the Team have invested significant efforts to develop a systematic approach towards knowledge and technology transfer, which has established a centralized technology transfer office of the Academy of Sciences. Beyond the field of physics and engineering, the department contributed to an exhibition promoting science, in collaboration with the Institute of Psychology (“optical illusions exhibition“).	
H2.3	**Relation to practice**
The department shows a high relation to practice, in particular in the field of laser joining and laser interferometry.	
H2.4	**Participation in AV21 strategy**
See Institute report.	
H2.5	**Cooperation with regions of the Czech Republic**
The department is strongly contributing to the competitiveness of Czech industry in different regions (e.g. Meopta-Optika, TESCAN, Mesing). In addition, several regional cooperations with research institutions (e.g. Czech Metrology Institute, CESNET) have been established.	

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
Within the department, the Team “Coherent Lasers and Interferometry” is performing unique activities, which are of high scientific and technological impact, compared to other international institutes. In the case of the Team “laser technology”, there are several institutions worldwide dealing with similar topics. However, in the field of laser joining methods, the Team has shown to have extraordinary experience, in particular when implementing monitoring concepts as well as welding strategies.	

D1.2	Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperations
The department shows an extensive enrolment in international collaborative research projects. Some areas are internationally recognized, such optical frequency references/absorption cells, and interferometric systems.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The Team has organized an international summer school in the field of microwave research and optical engineering, electronics as well as photonic technologies for Terahertz technologies and applications. It has also regularly co-organized the LASER conference in the Czech Republic. The amount of invited lectures could be improved considering the large number of members (~25) of the Team. The team members have received 5 awards which is outstanding.	

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

D2.1	Direction in line with the perspective of the planned research directions
The department continues research activities in line with the core experience of the Team and also in new research areas.	
D2.2	**Assessment of the previous research objectives and their achievement**
The department has addressed satisfactory the previous research objectives and achieved many of them.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The department has strongly increased its participation in international projects (mainly founded by the European Union), primarily in the frame of the EURAMET program. It has also successfully addressed new research topics such as in the area of quantum-technologies. Efforts to improve the “fragmentation of research activities” have been implemented.	
D2.4	**Success in receiving grants**
The department has shown a high success-rate for receiving grants, in particular from the European Union. The number of members of the Team has slightly increased from ~23 to ~25, which confirms the success in acquiring research funding.	
D2.5	**Adequacy of instrumental equipment**
Instrumental equipment seems to be adequate at the moment. However, since typical research grants only cover personal costs, high-impact research activities requiring advanced instrumentation could be more difficult in the future.	
D2.6	**Effectiveness of management**
Taking into consideration the relatively large size of the Team, performed projects and originality of some of the topics, management can be considered very successful.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The Team consists of experts from different areas. The age structure of the Team shows a good balance, being distributed between 25 and 55 years. The success rate of the PhD students is 100% and the department intends to grant them continued employment.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

The strategy of the Team is in accordance with the Institute development plan.
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.**
Not relevant for the further development of the Team.

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 several collaborations with universities. At national level, it cooperates with Palacký University and Brno University of Technology. At the international level, with University of Innsbruck (Austria), University of Modena (Italy), Technische Universität Ilmenau (Germany), University College London (UK), Université Paris (France), Technische Universität München (Germany), etc.	
D3.2	**Effectiveness of joint research centres**
The department has established several cooperation in the form of joint research centers, including the “Centre of Excellence for Classical and Quantum Interactions in Nanoworld”, the “Competence Centre – Advanced Microscopy and Spectroscopy Platform for Research and Development in Nano and Microtechnologies”, the “National Competence Centre – Centre of Electron and Photonic Optics” and the “Interdisciplinary Collaboration in Metrology with Cold Quantum Objects and Fibre Networks”.	
D3.3	**Success rate in supervision of PhD students**
Three PhD students successfully defended their thesis. The department has a 100% success rate in supervision of PhD students.	
D3.4	**Participation of PhD students in the outputs**
The PhD students contributed to the team outputs in form of scientific publications, and were also involved in different research projects.	
D3.5	**Participation of the team in master or bachelor studies**
The amount of master and bachelor theses is outstanding (15 and 33, respectively).	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The number of lectures, seminars and courses in the evaluation period is outstanding, showing a great dedication of the team members in teaching activities.	

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

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Activities concerning the area of research popularization have been adequate in the evaluated period. This has been realized through the cooperation with young graduates such the “Amazing Theatre of Physics” as well as through collaborations with the “Brno	

Observatory and Planetarium“ and the “Science Centre VIDA“. Scientists from the DCO contributed to several educational projects, by designing several demonstrational apparatuses, and also implemented this equipment in several demonstrations and popular science shows. They have also participated in the “week of science” as well as in the “Trade Fair of Science“ and organized a “laser show”, between others.	
D4.2	**Publishing activities and its quality**
For dissemination to a wider audience, see D4.1	
D4.3	**Participation in professional organisations in the area of research and development**
Wide range of involvement in evaluation panels, scientific societies, politics councils and advisory boards, between others.	

Other comments of the commission:

The impression of the Commission regarding the Team “Coherence Optics” is very positive. It has been able to perform research at a high level. The group “Coherent Lasers and Interferometry” is performing unique activities, which are of high scientific and technological impact and should be maintained in the future. The group “laser technology” is performing research at a high level for instance in the field of laser welding. However, these activities are not very visible at international level. Like for other teams of the Institute, the Team can increase its international visibility by placing symposia at already well established international conferences or by being involved in professional organisations in the area of research and development.

Final report was elaborated by:

Commission 7.2 - Engineering and technology
Evaluated teams No.: 1, 2, 3, 4, 5, 6

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