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

Summary Final Report

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

Evaluated teams and their leaders:

1. Astroparticle Physics (Petr Trávníček)
2. Experimental Particle Physics (Alexander Kupčo)
3. Particle Theory and Cosmology (Martin Schnabl)
4. Functional Metal Materials and Thin Films (Petr Šittner)
5. Dielectrics (Jiří Hlinka)
6. Magnetic Materials (Oleg Heczko)
7. Microscopic Theory of Advanced Materials (Jindřich Kolorenč)
8. Spintronics and Nanoelectronics (Tomáš Jungwirth)
9. Low-Dimensional Atomic and Molecular Structures (Pavel Jelínek)
10. Thin Films and Nanostructures (Antonín Fejfar)
11. Structure Analysis (Michal Dušek)
12. Semiconductors (Jiří J. Mareš)
13. Magnetics and Superconductors (Jiří Hejtmánek)
14. Optical Materials (Martin Nikl)
15. Classical and Quantum Optics (Ondřej Haderka)
16. Low-Temperature Plasma (Zdeněk Hubička)
17. Optical and Biophysical Systems (Alexandr Dejneka)
18. Fabrication and Analysis of Functional Materials (Ján Lančok)
19. Laser Interactions and Chemical Physics (Libor Juha)
20. Development of Lasers and Advanced Technologies (HiLASE) (Tomáš Mocek)
21. Laser Physics at ELI Beamlines (Georg Korn)

Part A: Evaluation of the institute

Overall evaluation of the institute elaborated in agreement of all commissions' chairs, who evaluated the institute.

Strengths:

- The departments of the institute have a very good mix of young talents and skillful,experienced researchers and a wide range of synergetic expertises.
- The gender and age-structure policy is proactive, the institute was awarded for HR excellence.
- The institute has excellent scientific infrastructure that is fully in line with needs of the individual research directions of each team.
- The scientific results are excellent and reported in leading journals.
- The teams have very high international recognition, which enables international collaborations.
- The level of funding is good and industrial interactions are growing, with some spin-out potential.
- The knowledge and technological transfer measures, towards the industry and society, are good, with growing revenues from commercial engagement.
- The training and supervision of the PhD students is of high quality.
- The developments at HiLASE are positive.

Weaknesses:

- Work on theoretical foundations is not fully integrated for some departments
- The number of international projects and research grant is too low in some of the departments.
- Structure of the budget.
- It is not typically to provide permanent jobs for those manning infrastructure.
- 'Velvet' profile in the age structure of some teams.
- For some researchers the range of research directions is too broad.

Opportunities:

- Operational funds: e.g., OP JAK (2022-'29).
- Increase actives to obtain more international grants at individual and consortium level, for example in Horizon Europe MSCA and ERC grants.
- CITT for technology development.
- Slovanka for site development.
- Prospect for positive engagement with AV21 goals.
- To attract more students and young researchers from the Czech Republic and other countries together with highly qualified experts to improve the research potential and exchange of knowledge.

Threats:

- Not enough experienced researcher who can conduct original research at the highest level, lead international teams, and succeed in large-scale grant applications.
- Difficulties in attracting talented workers from abroad.
- Difficulties in attracting students, especially for PhD work.
- 70 % of "volatile" budget (grants).
- The relatively low level of salaries in research hinders hiring and long-term employment of best scientific minds.

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

H1.1	Quality of selected outputs of Phase I

Across the breadth and variety of teams, the level of quality was relatively good, in a general sense, and the comments of the earlier evaluation in Phase I are reasonable in their assessment of this across IP. There are also some noted industrial interactions and efforts in applied research with marked commercial/societal potential, and this recognition was reflected in some well-placed Phase-I comments.
The quality of the majority of selected outputs is very high. Similarly oriented departments in the field of Materials Engineering during the evaluation - Phase I have been evaluated and compared. According to the results from the evaluated 5 departments from the Institute of Physics three departments finished on the 1. 2. and 4. positions between the 16 evaluated departments in the productivity of excellent, world–leading and internationally excellent outputs. The remaining two departments in this comparison finished at average or below average.

H1.2	Contribution of workers on the outputs reached

There is a broad distribution across all teams in IP towards outputs, spread all throughout the institute. Several teams with only few members have achieved outstanding contributions.
The contribution of team workers to the outputs is significant. In the field of Materials Engineering, between the 16 evaluated teams one department from the IP is the first in the productivity of teams with regards to the excellent quality of the outputs. The contribution of the department members to the outputs in other departments is less but also significant. There is one department that underperforms with regard to output quality.

H1.3	Quality of all outputs and results

These generally are of good to high quality, with solid journal-publishing and patenting performance. There are also some excellent, high-impact prestigious publications.
From total number of outputs 760, 48 belongs to the top decile and 81 to the first quartile, while the rest of the publication is uniformly distributed in quartiles 2-4.

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

There are many highlights from which to choose, and a non-exhaustive list would include, in no particular order:

Relativistic spintronics (e.g., unconventional d-wave magnetism);

Advances in scanning microscopy and on-surface (2D) chemistry;

Electron crystallography;

Nitride-based high-speed scintillators;

Transient magnetic fields in laser driven plasma;

Understanding the deformation mechanisms in NiTi wires;

Fluorescent nanodiamond particles demonstrated as biocompatible DNA carrier and optical monitoring of DNA release;

Direct observation of twin refinement at nanoscale in a bulk MSM Alloy;

Fabrications of highly sensitive gas sensors;

Development of nanoparticles for bio applications;

Development of a new plasma diagnostic method;

Deposition of functional thin and thick TiO2 films for industrial applications;

Application of non-thermal plasma for desinfection and to foster healings, etc.

H1.5	Contribution of the participation of the authors in large collaborations
This is positive, as many of the teams have H-2020 engagement, and the JANA initiative in Team 11 is an example of international leadership is such a collaborative effort. There was also a significant contribution to large collaborations from Teams 1 and 2. Team 19 was involved in several large collaborations on free-electron lasers. Team 21 was leading part of the Laser centres in Europe initiative.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Across the broad range of the IP's teams' activities, these address many pertinent societal questions and issues, such as energy, functional materials, water quality, security and biomedical technologies – all important 21st-century issues**.** The commission found the outputs and results of the evaluated departments in perfect harmony with the mission of the Institute and the CAS.	
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 commission found the system for knowledge transfer to society is fully developed and effective. There are some excellent examples in Teams 11 (JANA) and 12 (joint patenting with companies), Team 20 (sample processing with laser; laser treatment and prototyping, laser testing). There are also teams with a promising application potential of their knowledge transfer into practice (e.g. Team 8, Team 21) to be developed.	
H2.3	**Relation to practice**
The positive relation to practice is documented by industrial partners from the Czech Republic and Europe as TESLA Electrontubes s.r.o., Czech company Bioveta, CARDAM, Admedes GmbH, etc. It is suggested that the institute further develops such relationships as part of knowledge transfer activities. Further examples deserve mentioning, such as JANA workshops, software distribution, also joint patenting with industry, several licenses for technology and technical solutions and for software, laser processing and other research services.	
H2.4	**Participation in AV21 strategy**
Some teams are directly involved in this strategy, but this was not emphasized to any great extent. According to the statement of the institute, they took part in VP01, VP03, VP05, VP06, and coordinated VP17.	
H2.5	**Cooperation with regions of the Czech Republic**
The departments cooperate with universities, research institutions and companies in several regions of Czech Republic such as the Brno University of Technology (VUT) in Brno. VŠB Ostrava, Olomouc [JLO with UPOL] and Univ. Pardubice.	

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
These are usually quite competitive and very good. For instance, Team 8 is truly world-leading, whilst other teams (such as 9, 11, 15) are also more advanced compared to similar-sized groups on an international stage.	
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 departments are involved in many high quality international and national cooperations, partly in a leading position, which is very good. Examples are collaborations with the Ohio State University, USA, Taiwan Instrument Research Institute, Taiwan, Swiss Federal Institute of Technology Lausanne, Switzerland, IFW Dresden, Germany, etc. The scope of the cooperation is in agreement with the scientific orientation of the individual departments.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
There is a very healthy level of workshop organization, e.g,, JANA, prestigious FQMT meetings, etc. In total, 58 more or less important conferences and workshops were organized (e.g. annual HiLASE and ELI workshops). Furthermore, the workers of the individual departments are very active in different scientific communities, in presenting invited lectures, and act as editors of international journals.	

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

D2.1	Direction in line with the perspective of the planned research directions
These are broadly well-placed and in agreement with the planned research direction of the Institute as well as with wider strategic goals of CAS, and appear to be informed by general AV21 aspirations, although this latter point was not addressed in much detail.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previous research objectives have been mostly met successfully. They have been partially intensified for very promising research directions or, in some cases, new emerging results lead to new objectives. This is in accordance with the previous recommendations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations from the last evaluation were taken into account and corrective measures were implemented successfully at all evaluated departments.	
D2.4	**Success in receiving grants**
The departments were very successful in acquiring national grants, for example, GAČR, TAČR, and also especially in terms of EU structural and operational funds earmarked for the Czech Republic – allowing for the development of an impressive infrastructure. It is also good to see a very encouraging overall IP ratio in favour of grant funding, and competitiveness at the H2020 level also (ERC, Marie-Curie ITN, etc).	
D2.5	**Adequacy of instrumental equipment**

In general, the departments have very good and state-of-the-art equipment, aided and abetted by EU structural/operational funds, although there are some questions relating to the sustainability and permanency of manpower. The commission also admires the capability to built advanced and custom-made equipment.	
D2.6	**Effectiveness of management**
The departments are effectively managed with awareness and addressing of age structure and gender challenges and with clear support from the institute, which obtained the European Commission's HR Excellence in Research Award. This creates a good environment for performing original high-level research with intra-IP, national and international collaborations, and findings reported in top journals. Further, there is emphasis on some industrial and infrastructure engagement and building.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The HR policy and the professional composition of all teams are mostly good. The age structure of the teams is in most cases suitable to meet their science character, including both experienced and ambitious young researchers. A few senior researchers are active to pass their knowledge on to the younger generation.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Work-life balance conditions are well regulated at the institutional level (maternity leave, part-time employment). The gender balance among scientists in the departments is approximately 30 % female which is good in an institute of physics. The Institute of Physics is an equal opportunity employer and actively encourages hiring of new employees in all under-represented categories.	
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.**
Only Team 21 (ELI beamlines) is supported in part by this program and is well integrated into the Institute.	

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 departments are very active, with extensive and impressive levels of productive collaborations in teaching, supervision of PhD students and research with universities on national and international levels, e.g. with Charles University, CTU, BUT Brno, TU Liberec or universities in France and Germany.	
D3.2	**Effectiveness of joint research centres**
A few teams established joint research centres with universities (e.g. Team 8, Team 15). These enabled them to create a very effective combination of top science and high quality education, with a significant number of common publications from the joint work.	
D3.3	**Success rate in supervision of PhD students**

Bearing in mind the inherent difficulty in recruiting PhD students, they are being well supervised typically, with good levels of attention. The success rate at the departments is good and the number of PhD students is constant over the years.	
D3.4	**Participation of PhD students in the outputs**
The PhD students are well engaged in the outputs of the departments during the course of their studies and are co-authors of many publications or posters. Often they are the first authors.	
D3.5	**Participation of the institute in master or bachelor studies**
This is very healthy, Participation of the departments in master and/or bachelor studies is significant and committed indeed with most teams having several (or more) teaching courses per year at nearby universities. This creates a good chance for recruiting new PhD students for the departments.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The cooperation intensity of the departments with universities in the form of teaching is generally positive, with multiple courses per annum for most teams. Still, there is space for improvement.	

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 the departments is remarkable and the departments are very active in research popularization through, for example, Open Door Days, Science Fair, Prague Planetarium, Journal Club, etc.	
D4.2	**Publishing activities and its quality**
The departments are active with contributions such as books and articles in national and international newspapers and magazines that target the general public. These efforts could be strengthened a bit, for example with op-ed components.	
D4.3	**Participation in professional organisations in the area of research and development**
The participation of the departments in professional organisations as scientific commissions, evaluation panels, scientific councils, editorial boards, organization of conferences etc., is significant and generally very satisfactory.	

Other comments of the commission:
The Institute of Physics comprises research teams across a rather wide range of research activities. It is internationally recognized in many areas of its scientific work.
As the individual evaluations of teams demonstrate, all of them have a high international standard, most of them exhibiting world-leading and internationally excellent outputs that exceed the average productivity in the different fields. Several teams are worldwide at the forefront of research in their field of research and development.

Moreover, most of the teams have a very good cooperation with universities and research institutes in the Czech Republic as well as internationally, and are able to acquire quality domestic and international grants. Many of the teams also have very good outreach and pedagogical activities, and some of them already started application and exploitation activities with commercial partners.
Thus, the Institute can be described as an international centre of scientific excellence, with strong and well-equipped teams, and with a good management of the Institute as a whole.
A specific comment on the situation regarding the PALS centre: In a satisfactory answer, the director of the Institute of Physics stated that further consolidation of the current situation is intended. All three existing laser facilities (PALS, HiLASE and ELI Beamlines) are trying to identify synergies and have a history of intensive collaborations. The ELI Beamlines will be part of ELI ERIC very soon, working primarily on the European level and being part of the landscape of European research infrastructures. We hope and believe that the good relations between ELI, HiLASE and PALS will stay.

Part B: Evaluation of the teams

1. Astroparticle Physics

Strengths:
Visible contribution in instrumentation and data analysis to several world leading experiments.

Weaknesses:
No scientists between 50 and 65, currently CZ PhD students only**.** Strong growth of the group which needs to be maintained in order to keep the high visibility.

Opportunities:
Acquire and maintain key experimental techniques with world-leading knowledge which can be applied to several experiments.

Threats:
Contribution to too many different experiments which could lead to too little impact of each experiment.

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

H1.1	Quality of selected outputs of Phase I
The team did not take part in Phase I of the evaluation, since the number of publications with more than 30 authors is the dominant part of the output of the group. However, the group generated some high-quality publications with less than 30 authors.	
H1.2	**Contribution of workers on the outputs reached**
The team is a founding member of the Pierre Auger Observatory and designed, produced and operates key components (fluorescence detector) of the experiment. The observation strongly depends on the reliable operation of these detectors. They also operate FRAM-telescopes which provide essential information for the operation of the experiment. This technique is also applied to the other big involvement of the group, the CTA observatory. Central role in the instrumentation of the LSST observatory.	
H1.3	**Quality of all outputs and results**
Excellent contribution to the operation of the different experiments and lead in working packages for publication of results.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The observation of the large-scale anisotropy of cosmic rays above $8x10^{18}$ eV is an important measurement in the field of cosmic rays and was published in Science. The observation provides further inside in the origin and production of the highest energetic cosmic rays ever observed.	
H1.5	**Contribution of the participation of the authors in large collaborations**

The group acquired unique expertise in the operation of so-called FRAM telescopes, necessary for the interpretation of the data for AUGER and future CTA and SWGO. In addition, it has a leading position in the interpretation and publication of data. Instrumentation for the upcoming Vera Rubin Observatory LSST.

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Long-term strategic partnership where the team plays a central role in the relation between experiments and companies in the CZ republic.	
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 provides the link between the experiment and local industry. The high demand of the experiment helps to further increase the reputation of the company.	
H2.3	**Relation to practice**
Contracts for CZ companies.	
H2.4	**Participation in AV21 strategy**
The team has already started its participation in the AV21 program 16 - Space for the Mankind (package "gravitational Universe"). The contribution (preparation works for LISA and common activities with Astronomical Institute) started shortly after the evaluation period.	
H2.5	**Cooperation with regions of the Czech Republic**
Several other Czech institutes participate in the large collaborations as well and therefore there is a natural collaboration with these partners within the collaboration.	

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 output and the role are comparable 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**
The international collaborations in which the team participates are among the world leaders in the field of astroparticle physics.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Several team members play important roles in the CZ academic life as well as leading roles in the operation of the experiments. The group was involved in the organization of three workshops.	

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 planed participation in future experiments represents the logical evolution of the current activities and existing expertise can be taken over to the future activities. The research topic of the chosen experiments is very relevant for the development of the field.	
D2.2	**Assessment of the previous research objectives and their achievement**
Very good contribution to the field, both in instrumentation as well as data analysis.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
All recommendations were implemented, in particular the increase in number of students is impressive.	
D2.4	**Success in receiving grants**
There is a significant number of grants, in particular the GACR Junior Star project 2021 (outside the evaluation period)	
D2.5	**Adequacy of instrumental equipment**
The laboratories are well equipped in order to fulfil the responsibilities in instrumentation for the participation in the different experiments.	
D2.6	**Effectiveness of management**
Coherent program with clear vision for the future	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
A key to keep and to attract excellent scientists is the broad program within the field, meaning leading activities both in instrumentation as well as data analysis. Both is given in the group. The management has to make sure to support young scientist to get visible responsibilities within the collaborations.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The gender balance (4 women, 16 men) is about consistent with the fraction of women in undergraduate physics program, which speaks of a healthy team culture.	
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
Very good – common participation with national universities in large scale collaborations. The large-scale collaborations also include world leading international universities.	

D3.2	Effectiveness of joint research centres
N.A.	
D3.3	**Success rate in supervision of PhD students**
Average number of supervised students. According to the documentation all PhD students succeeded with their PhD.	
D3.4	**Participation of PhD students in the outputs**
Typically the PhD students are contributing significantly to the scientific output. e.g. the cosmological studies of modified gravity relevant for the LSST were driven by a single PhD student and on top of that he achieved visible contribution to the experiment.	
D3.5	**Participation of the team in master or bachelor studies**
The number of master students increased almost by a factor of two compared to the previous period.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several regular courses were held at CTU and PU.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Impressive visibility in national media. Outstanding.	
D4.2	**Publishing activities and its quality**
The scientists managed to produce significant publications outside the large collaborations. This should be maintained for the future and, if possible, even increased.	
D4.3	**Participation in professional organisations in the area of research and development**
Given by the participation in large collaborations	

Other comments of the commission:

- Several participations in different large collaborations. The group has to make a wise decision on future participations, in particular to make sure that contributions are not subcritical, or existing visible contributions diminish due to missing manpower.
- Little interaction with astroparticle theorists. The group is mainly concentrated on experimental work. An increased collaboration with a theory group at a university with common publications might increase the attractivity and visibility of the group.
- Potential synergy with instrumentation activities (e.g. particle physics) with other related groups within the academy could be used for further capacity building.
- Collaboration with CAS Institute for Astronomy within the context of the LSST collaboration should be considered.

2. Experimental Particle Physics

Strengths:
Visible and essential contribution to several world class experiments. Unique expertise in experimental strong interaction physics.

Weaknesses:
Unbalanced age distribution with age gap between 55 and 65 and spikes between 30 and 40 and above 70. Little cooperation with theoretical groups.
Little internationalization of the group with scientists from CZ only.

Opportunities:
Focusing on fewer data analysis subjects might increase visibility even more. Synergy in detector development with other FZU groups can further increase R&D know-how.

Threats:
Increasing hardware responsibilities might shorten the room for participation in data analysis and contributions to collaboration papers. Uneven gender balance.

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

H1.1	Quality of selected outputs of Phase I
The team did not take part in Phase I of the evaluation, since the number of publications with more than 30 authors is the dominant part of the output of the group. However, the group generated also few publications with less than 30 authors.	
H1.2	**Contribution of workers on the outputs reached**
Key contributions to the operation and development of essential sub-detectors (i.e. ATLAS Tile calorimeter). Contributions to various data analyses and related publications (i.e. ATLAS gamma gamma -> mumu, Phys. Lett. B277 (2018) 303).	
H1.3	**Quality of all outputs and results**
The contributions to the development, operation and the data analysis in the different collaborations led to high quality publications with large impact factors.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The results obtained by ATLAS and ALICE collaborations are of high importance for the field. The measurement of the neutrino oscillation parameter with the NOVA experiment and the (possible) first observation of colorless 3-gluon C-odd state (Odderon) with TOTEM / D0 is also very important.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Essential and visible contributions to the large collaborations during several phases of the experiment lifetime, including construction, operation and analyzing of the results.	

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

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

Collaboration with CZ research institutes and close collaboration with CZ industries.	
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**
Knowledge transfer via cooperation with industry for large scale experiments. Scientific results contribute to key questions of humanity, like the origin of the universe.	
H2.3	**Relation to practice**
Little, only via cooperation with industry. Focus on fundamental science.	
H2.4	**Participation in AV21 strategy**
N.A.	
H2.5	**Cooperation with regions of the Czech Republic**
Collaboration with Czech research institutions mostly with experiments at Fermilab and CERN in instrumentation, computing and data analysis.	

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**
The research program is similar to other similar size national and international non-university research organizations. The slight focus towards hardware activities is typical for non-university research organizations and essential for the operation for large scale experiments.	
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 team cooperates within the world leading experiments on particle physics. Within these collaborations the team plays a very visible role in the operation of the experiments.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Organization of several national and international conferences and workshops on particle physics.	

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

D2.1	**Direction in line with the perspective of the planned research directions**
Participation with ATLAS in the HL-LHC upgrade and the participation in DUNE is well within the planned research direction of particle physics.	
D2.2	**Assessment of the previous research objectives and their achievement**
The research objectives are fully fulfilled, both for the envisaged activities within ATLAS, the neutrino activities and future detector R&D work.	

D2.3	Assessment of implementation of recommendations from past evaluation
The recommendations for LHC and for the neutrino program are well on track. The detector R&D activities strongly depend on the global activities on the next generation of experiments. The recommendation to “think out of the box” with participation in small scale experiments is still pending. This recommendation is still very valid and the group should actively look for smaller particle physics experiments to participate. This would nicely complement the current portfolio of the group.	
D2.4	**Success in receiving grants**
The team has good success in securing various grants mainly for CERN and is responsible for managing major grants in cooperation with CZ institutes. Mainly grants in cooperation with other national institutes.	
D2.5	**Adequacy of instrumental equipment**
Clean room facilities are essential for ATLAS HL-LHC contribution. Very good investment, also good for future detector R&D studies.	
D2.6	**Effectiveness of management**
The management structure is well adapted to the outline of the group with the different activities.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The scientific strategy with the participation in large scale experiments and R&D for possible future experiments is very good. The age distribution is uneven and in particular between 55 and 65 people are missing. The decrease in the number of scientists during the last years is a big concern. The team is CZ dominated and an internationalization of the group is still desirable.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Only about 10% female researchers, however, one of them in leading function (testing lab for Si detectors).	
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.**
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
Cooperations with universities on national and international level via experimental cooperations at CERN and FNAL.	
D3.2	**Effectiveness of joint research centres**
N/A	

D3.3	Success rate in supervision of PhD students
Six students successfully finished their PhD, two did not finish their PhD due to different reasons.	
D3.4	**Participation of PhD students in the outputs**
PhD students play a leading role in the collaboration publications and provide essential input.	
D3.5	**Participation of the institute in master or bachelor studies**
More than 10 master and bachelor theses have been finalized within the evaluated time period.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several teaching activities at different level by different members of the group at Charles University and Czech Technical University.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
High visibility and outreach activities at different levels, from public talks to TV appearance.	
D4.2	**Publishing activities and its quality**
Frequent activities with outstanding quality on different formats.	
D4.3	**Participation in professional organisations in the area of research and development**
Given by the participation in large collaborations.	

Other comments of the commission:

- Part of the group is a founding and long-standing member of the ATLAS collaboration with very visible contributions. In particular the participation in the experiments related to LHC (TOTEM and AFP) provides high visibility.
- The contributions to the upgrade program of ATLAS, in particular the success of the semiconductor tracker upgrade is of high importance for the ATLAS experiment.
- The participation in the data analysis of the ATLAS experiments is spread via different subjects. Focusing on fewer subjects might enhance the visibility of the group.
- The participation in DUNE is an excellent choice and has strong overlap with the existing Nova experiment.
- Detector R&D activities are essential for future experimental participation; synergies with other FZU groups (e.g. Astroparticle physics) should be taken more advantage of.
- The group should consider enhancing the publication of scientific results outside large collaborations, in particular phenomenological papers in collaboration with theoreticians.

3. Particle Theory and Cosmology

Strengths:

- Young, dynamical and diverse group with large international component.
- Focused research topics, with the newly established CEICO as a coherent framework.
- Contact of the cosmology group with observational and experimental teams and consortia (EUCLID, Telescope Array...).
- Good success in securing grants.
- High international visibility both in terms of talks and invited presentations and in terms of international incoming and outgoing postdocs.

Weaknesses:

- Lack of phenomenological expertise in the string group.
- Low level collaboration between the cosmology and string groups.
- Insufficient teaching at the undergraduate level.
- Low participation of women amongst the research staff/postdocs
- Too many papers in the lower percentiles in terms of citations and journal quality.

Opportunities:

- More intense collaboration between string and cosmology groups thanks to CEICO.
- New important results in cosmology stimulated by data.

Threats:

- Rapid growth from insecure funding, mostly based on grants, that could threaten sustainability.
- Difficulty in attracting PhD students due to weak ties with university teaching.

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

H1.1	Quality of selected outputs of Phase I
The quality is somewhat higher than average, with the majority of outputs in the two highest quality groups, and 20% of the outputs in grading level 1.	
H1.2	**Contribution of workers on the outputs reached**
Team members appear as reprint author about half of the time, which is reasonable in theoretical physics where papers have a small number of authors and no clear lead author exists.	
H1.3	**Quality of all outputs and results**
The quality of the overall output is not very high, with a strong peak in the second quartile in terms of journal ranking and in the lowest quartiles in terms of citation intensity. This markedly lower quality in comparison to the outputs selected for evaluation in Phase I suggests that the group publishes a substantial number of run-of-the-mill papers.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
High impact results from the cosmology group, constraining the abundance of dark matter and ruling out classes of models of modified gravity with gravitational wave data. Results on topological defects in string field theory.	

H1.5	Contribution of the participation of the authors in large collaborations
Most of the team's outputs come from small collaborations. However, team members from the cosmology group are members of the Telescope Array Collaboration and the LISA and Euclid consortiums.	

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 performed by this team addresses several fundamental questions in cosmology and theoretical physics, such as the origin of the universe, what the universe is made of, and the ultimate nature of fundamental interactions.	
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 team makes public its computing codes.	
H2.3	**Relation to practice**
Some of the public computing codes developed by the team may have applications that go beyond physics research, specifically in statistics. However, this has not been explored.	
H2.4	**Participation in AV21 strategy**
N.A.	
H2.5	**Cooperation with regions of the Czech Republic**
Not addressed.	

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
The team has the size of a typical theory group and it is of a good average quality in comparison to similar theory groups of other countries. The specialization on a restricted number of subfields helps in ensuring a good scientific standard.	
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 team has a strong international profile with members from 14 different countries. This facilitates international collaborations with some high-profile international researchers. Also, team members from the cosmology group are members of various international collaborations and consortiums (EUCLID, LISA, Telescope Array). There is a memorandum of understanding with the cosmology initiative of the Arizona State University.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**

A major international school and a major international conference organized locally in the field of cosmology; participation at the organization of a major string theory conference series. Large number of talks given at international conferences and workshops, including invited lecture series. Some awards for junior 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 research is now concentrated on a well-defined set of topics in cosmology and string theory. For each of these topics, there is a reasonably clear roadmap for future development. In cosmology significant phenomenological input is expected from sky surveys, gravitational wave research, and multimessenger astronomy. The reorganization of research activities with the creation of the new central European institute for cosmology and fundamental physics (CEICO) provides a framework that is likely to sustain and stimulate future research and collaborations.	
D2.2	**Assessment of the previous research objectives and their achievement**
Published research has largely followed the expected path.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
A rationalization of scientific activities was suggested, with members of the group working on nuclear theory being offered more direct opportunities to interact with experiment. The recommendation was implemented, and these members are now part of the experimental particle physics team.	
D2.4	**Success in receiving grants**
CEICO was funded with support from European structural funds and Czech ministry of education funds. This large grant supports the bulk of the group activities. A team member has transferred here a prestigious ERC consolidator grant. On top of these there are several smaller grants (including international ones).	
D2.5	**Adequacy of instrumental equipment**
Instruments relevant for the cosmology research are provided through the participation of team members in international collaborations and consortia.	
D2.6	**Effectiveness of management**
The effectiveness of management is demonstrated by the success in establishing CEICO, in rationalizing the scientific priorities of the group, in attracting scientists from abroad, and in fostering the career of younger team members.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The age structure is currently balanced while being quite dynamical, with no members older than 50, and a peak between ages 30 and 40. The career of young scientists has been effectively promoted as demonstrated by their success in the continuation of their careers in prestigious institutes.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**

The international attractiveness of the team especially towards younger scientists suggests a good working environment. The female representation is lows, but in line with the small number of female theorists in string theory. The group is encouraged to be proactive about gender representation when hiring new staff/postdocs, e.g. by actively reaching out and inviting strong female candidates to apply.

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.**
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 young, diverse and international nature of the team, as well as the many international collaborations, guarantee a high degree of exchange with universities both at the national and international level.	

D3.2	**Effectiveness of joint research centres**
One of the team members is a PI of a grant that launched the Eduard Čech institute, joint with the Masaryk University in Brno, the Faculty of Mathematics and Physics of the Charles University in Prague, the FZI, and the Mathematics Institute of the Silesian University in Opava. The institute has effectively fostered the collaboration between scientists at the institutions involved. The MOU with the University of Arizona (point D1.2) has led to various scientific exchanges.	

D3.3	**Success rate in supervision of PhD students**
A good number of PhD students were supervised, several of whom secured prestigious postdoctoral positions.	

D3.4	**Participation of PhD students in the outputs**
The participation of the PhD students as co-authors of main papers is significant.	

D3.5	**Participation of the institute in master or bachelor studies**
Small but non-negligible number of bachelor and master theses.	

D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The team does not report on any involvement with undergraduate or graduate level modules. Giving the size of the team and the perceived issues in recruiting PhD students, it is recommended that team members start to engage actively in university level teaching.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Active participation both in activities for students (Physics Olympiad) and for the general public (science fairs), including activities at the Brno observatory and planetarium. Participation in TV programs.	
D4.2	**Publishing activities and its quality**
No publishing activities in outreach.	
D4.3	**Participation in professional organisations in the area of research and development**
Participation in editorial boards, national funding agencies and scientific councils.	

Other comments of the commission:
None.

4. Functional Metal Materials and Thin Films

Strengths:

The team has excellent infrastructure for research and all team members possess very good scientific expertise and are leaders in their fields. The committee is impressed by the excellent scientific results of the team published in leading journals, which provides them a worldwide recognition in the fields of martensitic transformation and shape memory alloys, nanodiamond coating technology and segregation in metals and alloys. The team offers an excellent environment for PhD training. The technology transfer and commercialization activities are excellent.

Weaknesses:

There is a lack of experienced scientists, who have strong leadership capabilities and can shape long-term strategies. The team is scattered across several buildings, which is not positive for cooperative research and the exchange of ideas as well as knowledge.

Opportunities:

The management of the department should attract students and young researchers from other countries together with highly qualified experts to improve the research potential and also the PhD training. The members of the department should even stronger focus their activities on technological transfer towards industry and society. The commission recommends to be more active in fund raising at international level and in particular through Horizon Europe grants.

Threats:

There are no significant threats to the team or scientific progress.

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

H1.1	Quality of selected outputs of Phase I
The quality of selected outputs (32) of the department for Phase I is very good, with 19 outputs belonging to the highest output category. In the field of Materials Engineering between the 16 evaluated teams they are the first in the productivity of teams in excellent outputs as number of outputs per FTE in World – leading outputs and World – leading outputs + internationally excellent outputs.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of team workers on the reached outputs is strong. In the field of Materials Engineering between the 16 evaluated teams, this team is first in productivity of teams with regards to the world–leading outputs and internationally excellent outputs per FTE.	
H1.3	**Quality of all outputs and results**
From outputs (214) 15 outputs were in top decile, 14 in 1st quartile, 44 in 2nd quartile and 68 in 3rd quartile. It is suggested to further target on high impact publications and to enhance the participation in the first and second quartile outputs.	

H1.4	The most valuable discoveries and findings in the fields, their importance for the field
Many valuable results were reached/published during the evaluated period, which is a significant contribution to the research fields, e.g.: Deformation mechanisms in NiTi wires investigated by thermomechanical testing combined with x-ray diffraction and transmission electron microscopy; Thermomechanical experiments and modelling of functional responses of NiTi; Determination of full strain and stress tensors in ~15000 grains of polycrystalline 0,1 mm thin NiTi wire deforming via propagation of localized bands due to stress induced martensitic transformation in the tensile test; Demonstration as biocompatible DNA carrier and optical monitoring of DNA release; Overview and critical assessment of experimental data and calculated results on interfacial segregation and grain boundary embrittlement and formulation of a general prediction of grain boundary segregation.	
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 research of the department follows the mission of the institute and has significant societal relevance with contributions in the following fields: Development of NiTi based systems, pressure and/or force sensor, layer for protecting surface of zirkonium alloys, Zn based biodegradable medical implants, etc.	
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 department is very active not only in reaching excellent scientific results but also in strong knowledge transfer into practise.	
H2.3	**Relation to practice**
The positive relation to practice is documented by partners from the Czech Republic and Europe (NiTi stent producer Ella-CZ, ESA project focussing on the development of SMA fasteners, research for Admedes GmBh), etc.	
H2.4	**Participation in AV21 strategy**
The department participating in AV21 – New materials based on metals, ceramics and composites.	

H2.5	Cooperation with regions of the Czech Republic
The department corporates with universities, research institutions and companies in many regions of Czech Republic e.g. with The Brno University of Technology (VUT) in Brno.	

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 department is of very high scientific quality in comparison 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**
The department is involved in many high quality international and national cooperations, many times as the leader, e.g.: Ohio state University, USA, Taiwan Instrument Research Institute, Taiwan, Swiss Federal Institute of Technology Lausanne, Switzerland, Max-Planck-Institute for Intelligent Systems, Germany, etc.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The department members are very active in scientific community activities - organizing of conferences and workshops, invited lectures, awards, e.g.: Editors of International Journals - P. Šittner, P. Lejček, Membership in scientific commissions and boards - P. Šittner Membership in advisory boards of international conferences - P. Šittner, I. Stachiv., etc.	

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 followed directions fully agree with the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previously planned research objectives were assessed and the main research directions are followed or partially intensified for very promising research directions.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations after the last evaluation were taken seriously and there were actions to implement them, e,g,: The potential threat of deficiency of experienced top scientists with international reputation was solved by the reorganization of the department; The recommended enlargement of the staff because of the very perspective research topics and promising potential of the department was solved with newly hired scientists, and in particular through hiring more postdocs.	

D2.4	Success in receiving grants
The department is very successful in acquiring national grants mainly from GACR. It is suggested to intensify application for European grants.	
D2.5	**Adequacy of instrumental equipment**
The department possess excellent research infrastructure such as a Mechanical testing laboratory, a Metallurgical laboratory, a CVD diamond technology laboratory, and a FIB-SEM electron microscopy laboratory.	
D2.6	**Effectiveness of management**
The department is efficiently managed, creating a good environment for performing excellent research with priorities as: Research in fully autonomous research groups; Access to shareable experimental equipment; Orientation on grant research; Emphasis on PhD training; Research commercialization, etc.	
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 department is balanced enabling senior researchers to pass their knowledge and experience to the younger generation. The department is good in attracting young researchers from Czech Republic and surrounding countries in the evaluated period 16 scientists (55%) and 13 PhD students (45%) worked at the department.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Currently 9 out of 29 members of the team are female researchers. Considering that two out of the three groups are active in material engineering fields with traditional low participation of female scientists, this is an average number. Due to the equal hiring policy of the team and the female friendly gender policy of the institute it will probably further improve.	
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 departments is very active in collaboration with several universities on national and international level. Nevertheless, more activities are suggested in the next years. This will also increase the chance to participate in EU grants that are coordinated abroad.	
D3.2	**Effectiveness of joint research centres**
The department is involved in a number of national and international joint research centres, which is very good.	
D3.3	**Success rate in supervision of PhD students**
In the evaluated period19 students studied with the team, 8 students completed theses and 8 students still studying. Overall, the success rate is good.	
D3.4	**Participation of PhD students in the outputs**
At the department ca. 50% of the team members are PhD students. The PhD students are well engaged in the output of the department and are co-authors of many publications.	
D3.5	**Participation of the team in master or bachelor studies**
Several bachelor and master students were incorporated into the research at the department.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The cooperation intensity through teaching at universities is good.	

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 very active and successful in public outreach for audiences with different backgrounds from Czech Republic and abroad.	
D4.2	**Publishing activities and its quality**
The department has been regularly involved in presentation of the FZU research by demonstrating its laboratories and lecturing to the broader society. Several team members were involved in the public enlightenment program „Open Science“, which is very good.	
D4.3	**Participation in professional organisations in the area of research and development**
The staff of departments holds leading positions in different international research networks and committees, professional organisations, and evaluation panels.	

Other comments of the commission:

The commission recommends to maintain the efforts in realization high quality research and publishing scientific papers in top journals and in teaching activities as guest lectures at Czech universities as well as abroad. The management of the department should attract students and young researchers from other countries together with highly qualified experts to improve the research potential and scientific progress of the PhD candidates. The members of the department should focus to technological transfer of the obtained scientific results towards the industry/society. The commission recommends to be more active in receiving larger international cooperative projects and individual projects as e.g. MSCS and ERC grants.

5. Dielectrics

Strengths:
Ferroelectric materials and properties, broad variety of research

Weaknesses:
1/3 publications in quality group 3-4.

Opportunities:
Synergy and increased interaction between groups.

Threats:
Continuity of infrastructure; ongoing funding challenges.

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

H1.1	Quality of selected outputs of Phase I
Some of the published work is internationally leading (quality group 1), especially that from the ferroelectric materials groups, while the bulk of the outputs of the team can be characterized as internationally recognised (quality group 2). It would be helpful for the team in the next evaluation to try and lift up the not-insignificant number of submitted outputs of the quality group 3 to the next level, and to be a bit more ambitious in the choice of journals.	
H1.2	**Contribution of workers on the outputs reached**
The respective groups of the team show good collaboration and contributions towards the overall outputs of their groups. For the fields of research covered, the number of authors on their publications is comparable to that of other groups worldwide.	
H1.3	**Quality of all outputs and results**
Naturally, the selected outputs were those to be perceived as the best ones over the period of the last 5 years. Their average ranking was firmly rooted in the quality group 2, which corresponds to internationally recognised work with about 15% of the outputs being internationally leading. The overall quality of outputs is somewhat lower, closer to a quality category 3 ranking. This is due to a relatively large amount of publications in the lowest quality group. Only few of these were in fact submitted for the evaluation. To improve the overall quality of outputs, one could advise to concentrate on possibly less but higher-quality publications, for example by avoiding publications in national journals and avoiding incremental research outputs.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team covers a broad range of research areas, among them ferroelectric solid-state materials and interfaces, semiconductor nanostructures and liquid crystals. All of these fields have delivered significant contributions to fundamental understanding of materials physics, as well as applied physics. One example would be the studies of the cubic phase of barium titanate, probably the most investigated model ferroelectric known. Other examples are the studies of THz spectroscopy on nanostructures and the creation of organic nanotubes from mesogenic (liquid crystalline) materials. These investigations have not only contributed valuable insight into the fundamental physics of ferroelectric materials, but also show importance for novel materials development and device physics.	

H1.5	Contribution of the participation of the authors in large collaborations
The team is involved in some EU projects and COST actions and is a valuable partner in these, playing a similar role as the other partners. There are also some international collaborations between individual groups, which are on an equal-contribution basis. The involvement and contribution of the team in collaborations is absolutely fine and adequate. Within normal variations, the funding portfolio of the team has stayed constant during the last evaluation period.	

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 outputs of the team have led to a range of collaborations with application-focussed background and motivation, which are relevant to the Czech and wider general society. This ranges from multidisciplinary research with groups in the medical sciences for example in the development of Magnesium ropes for surgery to collaborations with local companies in instrumental development. But also in a wider sense the work of the team is of relevance to society, for example in the education of PhD students, university students and the general public through open days and hands on lab classes. Further, the team contributes to the international scientific society in positions within learned societies, review and evaluation of research projects, as editorial board members for scientific journals, and by the very active organisation activities of conferences and workshops.	
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**
Knowledge transfer into practice has been demonstrated by the development of measurement instrumentation and piezoelectric components, which have become commercially available. Also the progress in materials development for biodegradability and medical applications need to be mentioned here, as well as the materials development in liquid crystals, which provides research for future applications of soft matter materials in sensors, robotics and electro-optic devices.	
H2.3	**Relation to practice**
A large amount of the research done by the team is obviously related to the gain of fundamental insight and understanding of physical processes and materials. But as mentioned above, there are of course also example where this research and understanding is translated directly or indirectly into practical applications. It is believed that the ratio between fundamental physics, applied physics and applications is very well targeted.	
H2.4	**Participation in AV21 strategy**
This has not been discussed specifically.	
H2.5	**Cooperation with regions of the Czech Republic**
There are some collaborations with local universities as well as local companies. The cooperation also extends into teaching at several universities. We believe that the extent of collaborations is adequate for 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
In comparison with other international groups and institutes, the Dielectrics team is very well established and competing at a favourable level. They do not quite compete with the world‘s leading groups, but are surely internationally recognised and 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 consists of six groups which all follow an overarching concept of the study of dielectric materials, but which are thematically relatively independent of each other. One should thus rather discuss the groups involvement in international and national collaborations than that of the complete team. In this sense the groups are involved in good quality collaborations, they are well engaged and produce very good collaborative results. Many of these collaborations are on a group-to-group basis, rather than within huge consortia. We believe that this is indeed the more productive and practical way for the groups to collaborate and we would generally encourage this way of working together with other groups, nationally as well as internationally. At present, the scope and quality of international and national cooperation is very adequate and well chosen.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Members from all groups within this team are very active in the organisation of conferences and workshops at all levels. This ranges from large international conferences, for example the FLC2015 or CPSEM2018, to smaller topical workshops, for example on topological structures of ferroics. Team members regularly give invited lectures and have also received international and national awards. The team members are further active in the representation and leadership of national and international learned societies. All these activities are at a very good standard in comparison to similar teams and groups.	

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 planned research directions focus on magnetoelectric coupling, electric skyrmion phases and ultrafast dynamics in semiconducting nanostructures, as well as exotic transient states/out of equilibrium systems. We believe that these are interesting and timely topics, which are in line with the previous work and the new developments in respective fields and are worthwhile pursuing, while maintaining the present research of the other groups in the team. The recent involvement with MAGNELIQ and the EXPRO project is spot-on to deliver on these new perspectives.	
D2.2	**Assessment of the previous research objectives and their achievement**
We could not find any details about the previous recommendations and research objectives, other than a self-made statement that these were fulfilled.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
It can be assumed that this was done satisfactorily.	

D2.4	Success in receiving grants
The team was quite successful in generating grant income over the period of the evaluation, and apparently even more so since then. Within natural variations, about 1/3-1/2 of the funding was institutional, while the rest was generated via external grants. This is approximately the ratio one would expect for a successful team, probably even being on the better side.	
D2.5	**Adequacy of instrumental equipment**
The team has access to and runs a number of laboratories: THz, microwave, IR, Raman, dielectric spectroscopy, 2nd harmonic generation, calorimetry etc. All of these labs are modern and well equipped for the research being performed. There is currently no urgent need for major and significant equipment investments. The available instrumentation is adequate for the research proposed for the next few years.	
D2.6	**Effectiveness of management**
The impression of the commission was that the team is very well and effectively managed.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The age structure looks very healthy with a few more scientists at younger age (<40) and a constant age distribution for more senior staff, within normal fluctuations due to statistics of small numbers. We did not discuss issues of career development and progression in particular, but the fact of a constant age distribution points towards a low number of staff fluctuations. Career progression normally is not a team specific issue, but guided by the institution as a whole.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The ratio of women lies between 20-25%, which is a standard proportion in Physics institutions in most European countries. It is hoped that this will increase over the future years and the tools to achieve this should be put in place by the institution. From discussions it became clear that this is recognised and addressed at an appropriate level.	
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 team cooperates very well with other groups from universities, within the Czech Republic, but also abroad. The scope of these collaborations is adequate and comparable to that of other institutions.	
D3.2	**Effectiveness of joint research centres**
A number of research papers are published in collaboration with outside groups and groups abroad. This joint research is effective and brings together complementary	

expertise of different partners, which increases the quality and the effectiveness of research.	
D3.3	**Success rate in supervision of PhD students**
We find that the overall number of successfully supervised PhD students (9) is relatively low when considering the number of staff in the team (~40). It was not mentioned what the average intake of PhD students is, so it needs to be assumed that most of the starting students are eventually also successfully awarded their PhD, so that the rate of successful supervision might be high, albeit at relatively low overall numbers.	
D3.4	**Participation of PhD students in the outputs**
The PhD students fully participate in the outputs of their project.	
D3.5	**Participation of the team in master or bachelor studies**
The participation in Bachelors and Masters studies via project supervision is in fact quite low, with only 5 students successfully supervised by all staff of the team (~40) over the period of five years. We believe that this could be improved by a well-designed advertising campaign at the universities, a more pronounced presence via lectures and good planning of adequate projects.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several (4) members of the team cooperate with three different universities, in terms of lecturing and reading courses. Most of these do in fact teach two courses. On the other hand, overall, this is a rather small number of staff engaged at universities (~10%), which may also be reflected in the somewhat low number of PhD students that were successfully supervised (9). The commission would encourage a closer cooperation with local universities with respect to courses offered at the higher level (last year lectures, masters projects, postgraduate lectures). This would surely also help in the recruitment process of PhD students. Possibly the number of PhD students could also be enhanced by recruiting students from abroad.	

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

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Public outreach is becoming increasingly important and the team has well responded to this demand. Not only through the organisation of conferences and workshops, but also through interviews in TV and print media. Further, the participation in art competitions in relation to science, as well as presentations to high-school students and open days, or laboratory sessions, show a very good presence in research popularisation.	
D4.2	**Publishing activities and its quality**
We are not aware of any publications in relation to public outreach. But this would also not be expected in a subject like Physics.	
D4.3	**Participation in professional organisations in the area of research and development**
Several members of the team are engaged in learned societies, not only as members, as are many, but also in leadership positions, for example in IEEE or the ILCS (International	

Liquid Crystal Society), which generally also implies a similar engagement in the respective national societies. We feel that this engagement is absolutely adequate.

Other comments of the commission:

The commission would like to encourage more inter-group research activities within the Dielectrics team, because the present structure of the team does in fact offer plenty of collaborative multidisciplinary possibilities to do so. For example, solid-state ferroelectrics could be combined with ferroelectric liquid crystals. Similarly, one of the topics of future focus, skyrmions and topological structures is also a topic of quickly increasing interest in the field of soft matter and anisotropic fluids. Other examples could be switchable THz devices or the self-assembly of nanostructures, just to name a few. This issue was not discussed specifically and the commission did not have any particular questions towards this point.

6. Magnetic Materials

Strengths:
The department is a young perspective team with skilful and experienced researchers, which are between the best class researchers in selected topics. The department is strongly focused on basic science and is flexible for advanced research directions. The members of the department are involved in wide international cooperation. The good cooperation with universities guarantees them a steady student inflow and enough PhD students. Excellent equipment in joint laboratories.

Weaknesses:
In spite of the strong research activities, the ratio of excellent results is lower than expected. Problem with the age structure, missing middle age researchers. Missing theoretical resources, which will be a significant help in strengthening the scientific potential of the team. For the number of researcher a wide range of research subjects.

Opportunities:
To focus on the most advanced research topics with new PhD students and researchers on board. Strengthening the effort and activities in the field of applied science and in the knowledge and technological transfer. Further expansion of state-of-art equipment in joint laboratories.

Threats:
Possible generation problem connected with the key senior researchers.

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

H1.1	Quality of selected outputs of Phase I
Quality of selected outputs (21) of the department for Phase I is very high with 15 outputs belonging to the highest output. In the field of Materials Engineering between the 16 evaluated teams, they are the second in the productivity of teams in excellent outputs as number of outputs per FTE in World – leading outputs.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of the department workers on the reached outputs is significant. In the field of Materials Engineering between the 16 evaluated teams, they are above the average in the productivity of teams as regards the World – leading outputs and internationally excellent outputs per FTE taking into the consideration the corresponding author calculation.	
H1.3	**Quality of all outputs and results**
From outputs (208) 15 outputs were in top decile, 19 in 1st quartile, 51 in 2nd quartile and 73 in 3rd quartile.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Many valuable results have been reached/published during the evaluated period which are important for the research field, e.g.:	

Studies of magnetic properties of 3d-4f intermetallics under extreme conditions such as high and ultra-high magnetic fields, low temperatures, high pressures in parent and modified state by hydrogenation; Observation of magnetic domains by magnetooptical Kerr microscopy (Using monochrome blue LED light and active sample position stabilization); Direct observation of twin refinement down to nanoscale in a bulk MSM Alloy.

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 research of the department follows the Institute mission and has significant societal relevance with contributions in the following fields: Testing superconductive tapes for using in TOKAMAK, Magnetic Adaptive Testing, micropumps development, etc.	
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 department is very active not only in reaching excellent scientific results but also in strong knowledge transfer into the practise.	
H2.3	**Relation to practice**
The positive relation to practice is documented by partners as TOKAMAK, Boise U, etc.	
H2.4	**Participation in AV21 strategy**
The department is active in the field of Magnetic levitation (due to superconductivity) - joint project of the Institute of Thermomechanics and the Institute of Physics for study of lossless bearings for use in flywheel energy storages.	
H2.5	**Cooperation with regions of the Czech Republic**
The vital activity of the department is to provide and develop advanced experimental facilities for magnetic research in cooperation with Charles University and other interested parties which are the Joint Laboratory of Magnetic Studies (JLMS), now part of the Large National Infrastructure as the Measurement and Growth Materials Laboratory (MGML) and the Joint Laboratory of Low Temperature Physics (JLLTP).	

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 evaluated department is with high quality in comparison with similar international and national departments.	
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 department is involved in many high quality international and national cooperation, e.g.: Aalto University, Helsinki, high-resolution transmission electron microscopy in magnetic shape memory alloys; IFW Dresden, - magnetic domain observations by advanced Kerr microscopy; Boise State University, USA, one of the centres of MSM research in USA; Bulk rare earths intermetallic Moscow State University, Faculty of Physics. etc.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The department members are very active in scientific community activities - organizing of conferences and workshops, invited lectures, awards, e.g.: O. Heczko was a chairman of International Committee of ICFSMA (2016–2019); A. Andreev is a member of Editorial Advisory Board of Journal of Alloys and Compounds. E. Chitrova was a member of the Organizing Committee of the 57th EHPRG 2019 meeting in Prague, 1-6.09.2019; A. Lancok was a chairperson of konference “Mössbauer Spectroscopy in Materials Science 2018”, 25. –28. 6. 2018. in 2007.	

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 followed directions fully agree with the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previously planned research objectives were assessed and the main research directions are followed or partially intensified for very promising research directions/areas.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
In the frame of the recommendations the department managed partially to refocus the research topics to enhance the national and international impact of the research, mainly the MSM group; The department increased the collaboration with other teams of the Institute of Physics working in condensed-matter physics on related subjects and with research infrastructures as SAFMAT, etc.	

D2.4	Success in receiving grants
The department is very successful in acquiring grants and not only national grant but also important international grant as ERC – Jana Vejpravova 2017 – TSuNAMI (unfortunately left the institute), Horizont 2020 - MSCA – IF Ladislav Straka, etc.	
D2.5	**Adequacy of instrumental equipment**
The department is equipped with equipment for excellent research also thanks to joint laboratories with: Physical Properties Measurement System devices, cryostat, dilution refrigerator, and squid magnetometer, providing measurements of material properties (thermodynamic, cohesive, magnetic, electrical and thermal transport, etc.) in various combinations of a wide range of external conditions (temperature, magnetic field, electric field, hydrostatic pressure, uniaxial stress), etc.	
D2.6	**Effectiveness of management**
The department is efficiently managed, creating a good environment for performing excellent research with national and international collaboration, published in top journals but also for knowledge and technological transfer.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The general HR policy of the team is guided and enforced by the HR policy of the Institute. The Institute is a holder of the HR Excellence in Research Award certificate, which is awarded by the European Commission. There is a problem with the researchers with age between 50 to 70.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The department is very small with 10 FTE researchers with 22% of female members.	
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 departments is very active in collaboration with universities on national and international level, e.g.: In the field of superconductivity, related to magnetic phase transitions in intermetallic compounds, particularly uranium based, in cooperation with Faculty of Mathematics and Physics, Charles University, Ladislav Havela;	

Concerning the novel superconducting materials based on high-entropy-alloys will continue in cooperation with Faculty of Mathematics and Physics, Charles University, etc.	
D3.2	**Effectiveness of joint research centres**
The department is involved in a number of national and international joint research laboratories/centres, which are very effective. See H2.5.	
D3.3	**Success rate in supervision of PhD students**
During the evaluated period, 3 doctoral students defended their theses at the department.	
D3.4	**Participation of PhD students in the outputs**
The participation of PhD students in the outputs is evident. In the scientific work of the department the work of PhD students is invaluable as apparent from the publications. Without their participation the department could not do so many research directions.	
D3.5	**Participation of the team in master or bachelor studies**
During the evaluated period, 3 master students defended their theses at the department.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Supervision of students: O. Heczko has been a supervisor and consultant (supervisor-specialist) for several PhD and MSc studies; Also L. Straka became a supervisor-specialist. He participated actively in the leadership of the magnetic shape memory group of the MSM group, including mentoring PhD. students and postdocs; J. Vejpravová supervised several master theses within her nanoparticle group till 2017, etc.	

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 very active in activities as public outreach for audiences with different backgrounds. Members of the team repeatedly participated with practical presentations for general public.	
D4.2	**Publishing activities and its quality**
Typical public outreach activities of FZU are Open Day at the Institute of Physics, CAS, Z. Janů has been involved in International Young Physicist Tournament and also commented in TV Prima on magnetic measurements of “mental energy”, etc..	
D4.3	**Participation in professional organisations in the area of research and development**
The staff of departments holds leading positions in different international research networks and committees, professional organisations, and evaluation panels.	

Other comments of the commission:

The commission recommends to maintain or even increase the efforts in realization high quality research and publishing scientific paper in top journals and in teaching activities as guest lectures at Czech universities as well as abroad. With the aim to solve the generation problem and open possibilities for new scientific directions, the management of the department should attract students and young researchers from other countries together with highly qualified experts to improve the research potential and also the PhD study and activities. The members of the department should focus to technological transfer of the obtained scientific results towards the industry/society.

7. Microscopic Theory of Advanced Materials

Strengths:

A team mainly working on the fundamental principles of materials, which allows them to guide functionalisation and prediction of electronic properties of conductors and semiconductors. The team has good collaborations with experimentally working groups from different divisions and also internationally.

Weaknesses:

A weakness of the team could be seen in the absence of own experimental aspects, which would directly profit from the fundamental work. Direct, in-team collaborations are sometimes more effective than collaborations with outside teams.

Opportunities:

The commission sees one of the arising opportunities in the fostering of the societal relevance of the work done, for example the standards in health & security of drinking water. Further opportunities should arise from international collaborations, which appear quite strong.

Threats:

The commission did not see any particular threats.

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

H1.1	Quality of selected outputs of Phase I
The quality of the outputs is strong and solid, as exemplified by the Phase-I comments, where the earlier evaluation appeared to be attentive.	
H1.2	**Contribution of workers on the outputs reached**
It is clear that there is a widespread effort from across the wider team in a variety of different sub-themes of research, including electronic properties, field response, DMFT, superconductivity, electronic-structure calculations (with impressive effect for actinide oxides).	
H1.3	**Quality of all outputs and results**
The quality of research is strong, with very solid journal performance. A particularly prominent area is in DMFT, where we would consider the group/team to be world-leading in terms of both methodology and applications. The excitonic-condensation work (through the ERC project) is also very prominent.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The work of Mauro Pereira in ‘water-sensing‘ is wonderfully canny and useful in terms of “real world“ discovery and applications‘, whilst quantum transport in nanoscale systems is another area of great technical accomplishment deserving commendation.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Collaborative efforts are mostly with smaller- to medium-sized teams. It is excellent to see work alongside Team 12 at IP (semiconductors), whilst the many-body collaboration with	

Univ. of Hamburg is very important. The Aqua3S project, at H-2020 level, does show good European collaboration and engagement.

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's research addresses many pertinent societal questions and issues, such as energy, functional materials and water quality – all huge 21st-century issues.	
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 water-screening/analysis (Aqua3S) work is very important here, and is clearly an excellent example of knowledge transfer in action.	
H2.3	**Relation to practice**
There is a good record here with Aqua3S.	
H2.4	**Participation in AV21 strategy**
This was less discussed, with some brief mention during the presentation and ensuing Q&A. Still, Aqua3S does show AV21-type activities.	
H2.5	**Cooperation with regions of the Czech Republic**
This is strong, within IP itself (e.g., Team 12, and we enquired about Team 5, on dielectrics, to which the team is well-disposed). The collaboration with Charles Univ. (Havela, actinides) is also noted for Czech collaborations.	

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
We feel that this materials-theory team compares well with other similar-sized research teams internationally, and is very competitive as regards outputs.	
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 quality of such international cooperations is good, with, *inter alia*, Germany, Canada, Austria, Belgium and Poland. This covers both methodologies, underpinning theory, as well as applications. H-2020 engagement is also noted, *e.g.*, ERC-CoG and Aqua3S.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
This is very good: the lecture series in the Autumn school at FZ Jülich shows this participation, as well as several high-profile workshops and conferences. The membership of several members on international committees is impressive (*e.g.*, evaluation panels, advisory boards, etc.).	

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 planned directions are in line with overall CAS and IP goals, continuing with the structural strengths in magnetism and strongly-correlated systems, as well as dealing with non-equilibrium systems/processes.	
D2.2	**Assessment of the previous research objectives and their achievement**
The 2015-19 goals were well-placed, especially vis-a-vis handling age-structure and retirement issues.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
We judge that this has been well handled, by and large – especially the management of change manpower-wise (with the entry of four new postdocs into the team), and the consolidation of inter-team collaboration, which we note has been especially pertinent in the case of joint activity with Team 12 (semiconductors).	
D2.4	**Success in receiving grants**
This has been strong, especially at H-2020 level, *e.g.*, ERC-CoG and Aqua3S.	
D2.5	**Adequacy of instrumental equipment**
The 1,000+ core High-Performance Computing cluster at the IP is a good piece of infrastructure which appears to be suitable for the needs of the team, as Q&A during the presentation revealed.	
D2.6	**Effectiveness of management**
This seems to be effective, although the upcoming crop of retirements will be a key area in which strong and effective management will be important.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The expansion of research-activity portfolio in 2015-19 (non-linear optics in semiconductors) has been welcome, as are such forward-looking ambitions (magnetic materials with strong electron correlation, out-of-equilibrium phenomena). There could have been more said in relation to handling the upcoming series of retirements and addressing age structure, although the management of that in 2015-19 appears to have been done adeptly.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The IP as a whole has been making strenuous efforts in this regard within its power, such as allowing work-at-home one or two days per week, which is particularly helpful for young parents (particularly mothers). On gender *per se*, we note that the team's balance is not particularly out of line with that of IP, and it is 50:50 in the postdoc category.	
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
This is strong, with good collaborations with Charles Univ., Vienna, Brock, Hamburg, Leuven, Gdansk. The teaching at Charles University and Autumn-school lecture series at FZ Julich is also impressive.	
D3.2	**Effectiveness of joint research centres**
The Aqua3S initiative/project showcases good outcomes from such a joint research centre.	
D3.3	**Success rate in supervision of PhD students**
This is reasonable, bearing in mind the well-flagged difficulty in recruiting them. There does not appears to be any compromise in the quality of supervision. We are pleased to see three new PhD students, who have joined recently.	
D3.4	**Participation of PhD students in the outputs**
PhD students appear to be well-mentored and take part in several publications, as would be expected from good-quality supervision.	
D3.5	**Participation of the team in master or bachelor studies**
The teaching of about 4 courses per term, at both under- and post-graduate levels at Charles Univ. underscores this commitment.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
A standing/regular intensity of 4 courses per term is certainly demanding and impressive. Full marks on this score.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
This is more than sufficient, with Prof. Kolorenc's TV and public lecture activities.	
D4.2	**Publishing activities and its quality**
This is less developed, in a popular-science sense. Perhaps authorship of some op-ed pieces in the popular media might help.	
D4.3	**Participation in professional organisations in the area of research and development**
This is good – Psi-k, review panels for ERC, Czech Science Foundation and Czech Government.	

Other comments of the commission:

A strong group with some world-class outputs, with a good balance of methodology development and applications, and a keen eye for some technology transfer. Well-managed too.

8. Spintronics and Nanoelectronics

Strengths:

- the team initiated and remained at the forefront of research in the field of antiferromagnetic spintronics and topological magnetism
- the team has a very competent team leader
- the team produces excellent outputs, which have a promising application potential
- the team has very good cooperations with universities and research institutes in the Czech Republic and internationally, and is able to acquire quality domestic and international grants
- the team already started application activities with commercial partners

Weaknesses:

- the team has currently no visible weaknesses

Opportunities:

- application of own results in the field of spintronics
- defining a new applicational facet of spintronics

Threats:

- self-satisfaction of the team with the current situation

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

H1.1	Quality of selected outputs of Phase I
The quality of selected outputs is documented by the productivity in world leading and internationally excellent journals. The number and quality significantly exceed the average productivity of the field.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of team members on the outputs reached is high, according to Phase I of evaluation it is about 59 %.	
H1.3	**Quality of all outputs and results**
The quality of all outputs is also very high: from all outputs (129) by journal ranking 31 are in quartile (decil) Q1*, 22 in quartile Q1 and 43 in quartile Q2.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team opened a new direction in spintronics based on antiferromagnets or complex magnets in general. The aim is to remove the limitations arising from ferromagnetic materials. They developed both the materials and the spin-dependent transport effects, which are used in spintronics, and also came up with first spintronic devices.	
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 performs world-leading and internationally excellent research, supervises bachelor, master and PhD students, has rich outreach activities and is starting with the application of own results. In this respect it fully matches the missions of both the institute and CAS.	
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 performs research with an enormous application potential and already makes steps for its transfer into practice.	
H2.3	**Relation to practice**
Relation to practice is beginning to be realized above all though a long-term collaboration agreement with Hitachi Europe Ltd., which leads also to a direct project-related financial support of the team.	
H2.4	**Participation in AV21 strategy**
The activities of the team are in line with the AV21 strategy.	
H2.5	**Cooperation with regions of the Czech Republic**
There is no direct cooperation yet with regions of the Czech Republic.	

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 has without doubt a world-leading position in the field of spintronics.	
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 has an intensive and fruitful cooperation with many research institutions abroad as well as with a few Czech universities. A very prominent result of this situation is e.g. that team members have led two ERC grants and two Czech Excellence Centre grants already.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Team members had rich and outstanding scientific community activities. They organized e.g. about 7 international workshops on spintronics per year and within the evaluated period had 90 invited talks including plenary lectures at well-known international conferences.	

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 current team research is in line with the perspective of the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previous research objectives have been fully met.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
There were no special recommendations from the past evaluation, just a challenge: Continue this outstanding quality, interesting and competitive research. So far this challenge was fully met, but remains relevant for the future.	
D2.4	**Success in receiving grants**
Team members have led two ERC grants and two Czech Excellence Center grants. Moreover, they were also involved in two Horizon 2020 projects, one of which was actually coordinated by the team.	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment of the team is currently at an appropriate level.	
D2.6	**Effectiveness of management**
The management of the team is very effective, which is well reflected in results of the team.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The expertise of leading and senior scientists is complementary and covers the whole variety of disciplines involved in the team's research portfolio. Moreover, all senior scientists had previous long-term international experience. All this leads to a sound HR policy of the team.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team management creates work-life conditions and successfully enforces gender issues. As an example can serve the young successful (female) scientist Helena Reichlova.	
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 team cooperates intensively and successfully with universities on national and international level (e.g. with Charles University Prague, University of Nottingham, University of Regensburg, Mainz University, Technical University of Dresden, etc.).	
D3.2	**Effectiveness of joint research centres**
Joint research centres of the team with universities enabled them to create an effective combination of top science and high quality education.	
D3.3	**Success rate in supervision of PhD students**
The success rate in supervision of PhD student is very high. In the evaluation period the team supervised 10 PhD students, 3 of them already defended their theses.	
D3.4	**Participation of PhD students in the outputs**
Supervised PhD students participated in 16 outputs (research articles) of the team, and thus carry a significant part of the team‘s output.	
D3.5	**Participation of the team in master or bachelor studies**
Team members supervised 1 master student and acted as consultants of 1 bachelor and of 3 master students.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Members of the team had semestrial lectures for bachelor (4 lectures), master (2 lectures) and doctoral (7 lectures) students.	

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 had rich outreach activities in form of public lectures and media appearances.	
D4.2	**Publishing activities and its quality**
The publishing activities of the team are outstanding and their quality is at a very high level.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members participate actively in several domestic and international professional organizations in the area of research and development	

Other comments of the commission:
None.

9. Low-Dimensional Atomic and Molecular Structures

Strengths:
- a highly international and young team, the members of which are mostly below 40 years old
- the team has a very competent team leader
- synergy between experimental and theoretical groups
- the team produces world-leading and internationally excellent outputs
- very good cooperation with universities and research institutes in the Czech Republic
- advancement of methodologies in the field of research

Weaknesses:
- the team has currently no visible weaknesses

Opportunities:
- increase the proportion of international funding

Threats:
- questionable stability of some small groups within the team that are essentially fully self-funded
- self-satisfaction of the team with the current situation

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

H1.1	Quality of selected outputs of Phase I
The high quality of selected outputs is documented by the productivity in world-leading and internationally excellent outputs that significantly exceed the average productivity of the field.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of team members to the outputs is very high, according to Phase I of evaluation it is about 71 %. Very high is also the ratio of reprint authors from the team which is about 83 %.	
H1.3	**Quality of all outputs and results**
The quality of all outputs is also very high: from all outputs (77) by journal ranking are 34 in quartile (decil) Q1*, 8 in quartile Q1 and 26 in quartile Q2.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team made fundamental contributions to recent advances in scanning microscopes and to on-surface chemistry. It significantly contributed to the establishment of new analytical tools enabling characterization of single molecules with unprecedented spatial resolution.	
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 performs world-leading and internationally excellent research, supervises Bachelors, Masters and PhD students and has rich outreach activities. It explores novel	

materials and advances the methodology in the field. Moreover, it shares the home-built technologies (methodology advances) with other scientific groups.	
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 main focus of the team is on excellent basic science with no direct applications.	
H2.3	**Relation to practice**
There is up to now no direct relation to practice.	
H2.4	**Participation in AV21 strategy**
The top research of the team is in line with the AV21 strategy.	
H2.5	**Cooperation with regions of the Czech Republic**
There is no direct cooperation with regions of the Czech Republic.	

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 has a world-leading position in the field of the investigation of low-dimensional atomic and molecular structures with an unprecedented spatial resolution.	
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 has an intensive and fruitful cooperation with many universities and research institutions abroad as well as in the Czech Republic. This is proven by a number of high-quality common publications and bilateral grants.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Team members have rich scientific community activities; they organized also 4 international workshops and within the evaluated period had more than 40 invited talks.	

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 current team research is in line with the perspective of the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previous research objectives have been fully met.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
There were no special recommendations from the past evaluation. The evaluation was entirely positive and the panel wrote as recommendations: “The panel encourages the	

team to continue its excellent work while also taking particular care to protect its intellectual property." This challenge remains relevant.	
D2.4	**Success in receiving grants**
The team has been very successful in receiving research funding to support its activities. Most support has been secured from national funds (mostly Czech Science Foundation), including two prestigious projects a Praemium Academiae, Czech Academy of Sciences (1.2 mil EUR) and an Excellence EXPRO project, Czech Science Foundation (1.2 mil EUR). However, the department has also obtained international funding. It obtained or hosted projects fully or partially financed by the European Union, such as the Marie Skłodowska-Curie or International mobility MSCA-IF II programs.	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment of the team is currently at an appropriate level. The team, moreover, develops new investigation methods in the field of research.	
D2.6	**Effectiveness of management**
The management of the team is very effective, this is well reflected in the results of the team.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The structure of the team is very favourable: besides a few experienced senior scientists, who are below 50 years, the majority (more than 70 %) of researchers are below 40 years. Moreover, 60 % of team members are foreigners. The team has all of the classic predispositions to be successful in the future.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team management creates a balance for work-life conditions, and makes approaches towards possible gender issues.	
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 team cooperates intensively and successfully with universities on the national and international level (e.g., with Charles University and Czech Technical University, Prague, Palacky University, Olomouc, Aalto University, Finland, University of Alberta, Canada, etc.)	
D3.2	**Effectiveness of joint research centres**
Team members have established a close collaboration with the Regional Center of Advanced Technologies and Materials at Palacky University, Olomouc, started to perform experiments with the Molecular Nanostructures at Surfaces group at the Central European Institute of Technology (CEITEC), Brno, and maintain an active cooperation with Charles University, Prague, Faculty of Mathematics and Physics, programme branch - Surface and	

Interface Physics. The joint research centres with universities enabled to create an effective combination of top science and high-quality education.	
D3.3	**Success rate in supervision of PhD students**
The success rate in supervision of PhD student is high. In the evaluation period the team supervised 14 PhD students, 6 of them defended their theses. Moreover, they acted as consultants of 3 PhD students.	
D3.4	**Participation of PhD students in the outputs**
Supervised PhD students participated in 5 outputs (research articles) of the team.	
D3.5	**Participation of the team in master or bachelor studies**
Team members supervised 1 master student and acted as consultant of 1 master student. In the evaluation period 2 master students defended their theses.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Members of the team had semestrial lectures for Masters (10 lectures) and doctoral (2 lectures) students.	

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 members were actively involved in research popularization in many directions.	
D4.2	**Publishing activities and its quality**
The publishing activities of the team and its quality were at high level.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members participated actively in several domestic and international professional organizations in the area of research and development.	

Other comments of the commission:
None.

10. Thin Films and Nanostructures

Strengths:
Modern research topics with application prospects

Weaknesses:
Possibly theoretical support

Opportunities:
Applied research with impact in developing economies

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 rated as quality group 2 or 3 with about 10% of the selected outputs in in the world leading category, while the majority of the papers is internationally recognised. It would clearly be beneficial for the team if some of the outputs could in the future accomplish a higher ranking, moving a certain percentage from category 2 to 1 and 3 to 2. Possibly a somewhat more ambitious selection of higher impact journals for first submission would already help.	
H1.2	**Contribution of workers on the outputs reached**
The respective groups of the team show good collaboration and contributions towards the overall outputs of their groups. For the fields of research covered, the number of authors on their publications is comparable to that of other groups worldwide.	
H1.3	**Quality of all outputs and results**
There are quite a large number of (non-selected) publications in the lower ranking categories, which could possibly be avoided by not publishing incremental results, but rather concentrating on possibly fewer but high impact publications.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
One of the main successes from the applications point of view is certainly the participation in the EU NextBase project which achieved industrially produced solar cells in access of 25% efficiency. The contribution of the team was to develop profilometry solutions for the characterisation of thin film via Raman spectroscopy, which is needed for non-destructive quality checks during industrial production. The development of high efficiency solar cells is obviously of paramount importance for the development of green technologies. Other very valuable work lies in the field of silicon-based nanostructures, such as nanowires and silicon nanocrystals, which are important for the development of novel solar cells and luminescent materials such as quantum dots and quantum wires. At last, an important development is the setting up and expansion of further work on nano-diamonds, which will be a very interesting direction into the study of nano-photonics.	
H1.5	**Contribution of the participation of the authors in large collaborations**

The team plays an important role in large collaborations like the NextBase project, which will be EU funded also in the future.

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Green power production is becoming increasingly important, and solar cells are one of the means to have been predicted a bright future in respect to alternative energies. Thus the main output of societal relevance is the close collaboration with European partners to achieve cells with high efficiencies. Nevertheless, also the nanomaterials development based on silicon nanowires and silicon nanocrystals will find its way into applications, as will the development of thin film diamond structures for surface chemistry and medical chemistry. The outlined work on diamond based nanophotonics will be of importance for the developments in quantum-photonics and sensors.	
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**
Knowledge transfer seems to work very fine, as can for example be seen by the start of industrial production of high efficiency solar cells being planned for 2021. One can be confident that also the silicon nanocystals will be commercialised for the use in optoelectronic and photovoltaic applications.	
H2.3	**Relation to practice**
Again, much of the work done by this team has clear relations to practical applications, such as solar cells, photonics, optoelectronics, biological imaging or sensors.	
H2.4	**Participation in AV21 strategy**
This was not discussed specifically.	
H2.5	**Cooperation with regions of the Czech Republic**
Cooperations throughout the Czech Republic are taking place in the area of Prague, but also with universities in the rest of the country, for example through the joint Infrastructure laboratory in Brno and the University of Liberec.	

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
In comparison with similar international groups, the team is certainly evenly matched. It may not be one of the few worldwide leading teams, but it certainly is internationally recognised.	
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 has very good international cooperations via EU projects and NextBase, The Central European Institute of Technology (CEITEC) at Brno and nationally via large research infrastructures with the Laboratory of Nanostructures and Nanomaterials (LNSM). It plays an important role within these collaborations and contributes a high level.

D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Members of the team have organised large international conferences with approximately 350 participants, but also smaller workshops and international Summer Schools. The team members regularly give invited talks at conferences and have received a number of awards, ranging from scientific prizes to prestigious awards for outreach activities. All of the activities in relation to scientific communication are as they should be for an internationally involved and recognised team.	

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 planned research directions are very sensible and forward-looking with a very good potential for excellent work and the opening of collaboration with industry and other strategic partnerships.	
D2.2	**Assessment of the previous research objectives and their achievement**
This has not been discussed in detail but it appears that the team was evaluated to be at high level in the past.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
Again we did not discuss this in detail, but the issue appears to be fine.	
D2.4	**Success in receiving grants**
The team has a very good track record of attracting funding and receiving grants, including larger European projects with industrial involvement.	
D2.5	**Adequacy of instrumental equipment**
The four groups of the team are working well together in a synergistic way, which implies the cooperation with regards to instrumentation and equipment. One can thus conclude that the research equipment infrastructure is adequate and modern.	
D2.6	**Effectiveness of management**
The management of the team looks efficient and effective. The management structure is adequate for the five groups. A re-structuring of the senior management has just taken place, which appears to have progressed very well, leaving a relatively young group leader assembly. During that transition it would have been desirable to include more women at the researcher / group leader levels.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The structure of the team has recently undergone a complete generation change. The age structure is thus somewhat skewed towards younger researchers of age ~45 and younger, with a relatively large number of senior staff aged >65. This may produce slight problems in the sense that all of the leadership is relatively inexperienced. On the other hand, this also	

opens the opportunity for new and novel, timely research directions. Career progression is thus looking well, which should also help to keep the best scientists in the team.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
At first sight gender balance does not seem to be any issue in this team (35% women), but one needs to keep in mind that many if the female staff are in fact administrators, graduate and PhD students. At the leadership level the ratio of female staff is already reduced to 20%. With all staff being of younger age, this implies that it is unfortunately little likely that this ratio will significantly change in the future. Nevertheless, in general this appears to be the similar range than for most other groups in the area of Physics and can probably only be addressed on the larger policy scale for all of CAS.	
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 cooperations and engagement with other universities is absolutely adequate.	
D3.2	**Effectiveness of joint research centres**
The team is engaged in several joint research centres. These collaborations appear to run effectively and successfully.	
D3.3	**Success rate in supervision of PhD students**
In comparison to some other teams, team 10 is quite successful in attracting PhD students to their department. Given that the average time period to obtain a PhD is larger than 5 years, and that half of the PhD students successfully finished their studies over the evaluation period, this implies that (nearly) all starters do actually obtain their PhD, which is a very good success rate. We would like to mention that the time period taken for PhD is larger than 5 years, which appears to be a bit too long in comparison to most other European countries. In order not to disadvantage the students, one could possibly try to reduce the PhD period to about 4 years and compensate by recruiting slightly more students.	
D3.4	**Participation of PhD students in the outputs**
All of the PhD students participate well in the outputs of the team, which would be expected.	
D3.5	**Participation of the team in master or bachelor studies**
Again in comparison to other teams, the number of bachelor and master students is adequate and the success rate is high.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**

Six members of staff were actively involved in teaching at a number of different national universities, which seems to be an adequate scope of cooperation and engagement. This is reflected by the team being able to attract a relatively large number of PhD and Master students. Engagement with universities is fully adequate.

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 outreach activities, with open days for visitors, courses for teachers, talks and activities at schools, science fairs and festivals and likewise activities. One of the staff has even been awarded a prize for the popularisation of science and technology, a clear indication that outreach is successful and engaging.	
D4.2	**Publishing activities and its quality**
We are not aware of any publication activities with respect to outreach, which one would not expect for a team in the area of Physics.	
D4.3	**Participation in professional organisations in the area of research and development**
The team is very well engaged in professional organisations through membership, but also in leadership positions, such as the President of the Science Council of CAS and Science Secretary of CAS.	

Other comments of the commission:

The synergies and collaborations between different groups of the team were well noticed and provide an excellent use of the existing infrastructure, while being of scientific and research benefit for the whole team. The commission felt that it would be beneficial if the very good experimental work done by the team could be enhanced by theory support.

11. Structure Analysis

Strengths:

- the team has a highly qualified staff with major crystallographers recognized worldwide
- the experimental equipment of the team is at a reasonable level
- thus, the team can combine its undisputed methodological development with experimental activities
- the team has very good cooperations with research institutes and universities in the Czech Republic and internationally

Weaknesses:

- a partial dependence of the team research on other disciplines and with this the associated difficulty to obtain independent funding (grants)
- the unclear future of the further development of the well-known structure analysis program JANA

Opportunities:

- development of the structure analysis by electron diffraction on ultrasensitive materials related mostly to organic chemistry and pharmaceutical research
- complementation of the JANA2020 program with tools for magnetic structure analysis
- development of magnetic crystallography under extreme conditions: at low temperatures down to 0.3 K, high magnetic fields up to 70 T, and high pressure up to 30 GPa

Threats:

- there are currently no serious visible threats the team should be concerned about

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

H1.1	Quality of selected outputs of Phase I
The quality of the outputs is very strong, as exemplified by the Phase-I appraisal; the standard of this assessment appears to be robust.	
H1.2	**Contribution of workers on the outputs reached**
There is a good sense of concerted effort spread broadly in the wider team in a variety of different sub-categories of research, spanning, *inter alia*, JANA, sponge crystallography, magnetic structures and the newer area of mathematical crystallography.	
H1.3	**Quality of all outputs and results**
The quality of research is notably strong, with impressive journal performance. A particularly prominent area is in JANA and related developments (such as excellent training), where we consider the group/team to be world-leading in terms of state-of-the-art methodology, software and unique applications. The development of electron crystallography is a rather outstanding achievement.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
In our opinion, this is undoubtedly the development of electron crystallography, in terms of methodology and applications. The modernisation of JANA is another very substantial, world-beating development.	

H1.5	Contribution of the participation of the authors in large collaborations
This is top-rate and globe-spanning, with many joint collaborations. The H-2020 Marie-Curie ITN also does show good European collaboration and engagement.	

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's research addresses many pertinent societal questions and issues, such as minerals, energy, pharmaceuticals, which all constitute big 21st-century issues.	
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 JANA software modernisation, along with associated workshops and training, show clearly exemplary knowledge transfer in action.	
H2.3	**Relation to practice**
There is a good record here with JANA.	
H2.4	**Participation in AV21 strategy**
This was less discussed, with some brief mention during the presentation and ensuing Q&A. Still, JANA and pharmaceutical crystallography does show a good level of AV21-type activities.	
H2.5	**Cooperation with regions of the Czech Republic**
This is not as developed as international collaboration, due to the international scope of JANA-based collaborations, and developments in underlying mathematical methods of crystallography.	

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 commission feels that this crystallography team outranks most other similar-sized research teams internationally, and is world-leading in terms of outputs.	
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 quality of international cooperation is good, with, *inter alia*, Germany, USA, France, Britain, Japan, Slovakia, Portugal, and Tunisia. This covers both methodologies, underpinning theory, as well as crystallography applications. H-2020 engagement is also noted, *e.g.*, via a Marie Curie ITN.	

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
This is really excellent: the JANA workshops are truly world-leading, which are frequent and international in scope and attendance, with over 1,200 attendees in 2015-19! The organisation of several high-profile workshops and conferences is also noted, outside of JANA, e.g., International School of Crystallography. The membership of several members on international committees is impressive (*e.g.*, evaluation panels, advisory boards, special-interest groups, etc.).	

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, the planned directions are in line with overall CAS and IP goals, continuing with the structural strengths in magnetic materials, JANA and electron crystallography.	
D2.2	**Assessment of the previous research objectives and their achievement**
The 2015-19 goals were well-placed, especially vis-a-vis attracting students.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
We judge that these have been reasonably well handled, by and large – especially by the outreach efforts and JANA training, and, of course, the strong, high-quality publication efforts and outcomes, and also strong emerging collaborations within CAS-IP, e.g. Team 5 (Dielectrics).	
D2.4	**Success in receiving grants**
This has been solid, with some H-2020 activity, *i.e.*, Marie-Curie ITN.	
D2.5	**Adequacy of instrumental equipment**
This is adequate, although the construction delays in accessing ELI are unfortunate, and we hope that this will be rectified soon, to allow further developments in the team's access to advanced infrastructure.	
D2.6	**Effectiveness of management**
This seems to be effective, although the upcoming crop of retirements will be a key area in which strong and effective management will be important in the period ahead, with a large age profile in 70+, and also some in 55-60.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The expansion of research-activity portfolio in 2015-19 (*e.g.*, JANA-modernisation developments, sponge crystallography, magnetic materials, electron crystallography) has been welcome, as are such forward-looking ambitions. There could have been more said in relation to handling the upcoming series of retirements and addressing age structure.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The IP as a whole has been making strenuous efforts in this regard within its power, such as allowing work-at-home one or two days per week, which is particularly helpful for young parents (particularly mothers). On gender *per se*, we note that relatively little was imparted about this team's balance, although we note laudable aspirations about a respectful and	

friendly work environment of high-quality research leading to a balanced age and gender level over time.	
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.**
This was mentioned only briefly in presentation-time discussion, and so we cannot comment with any particular authority on this matter with respect to this particular team. However the director of IP has engagement plans vis-a-vis this initiative.	

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**
This is very strong, with good collaborations with Charles Univ. and Technical Univ. of Prague. The teaching at JANA training schools is also impressive.	
D3.2	**Effectiveness of joint research centres**
The Marie-Curie ITN initiative/project showcases good outcomes from such a joint research centre. Concerning ‘sub-contracting‘ code development (e.g., JANA) to professional programmers, the commission welcomes that this is not the philosophy in the team and that this complex code development is best kept in-house.	
D3.3	**Success rate in supervision of PhD students**
This is reasonable, bearing in mind the well-flagged difficulty in recruiting them. There does not appears to be any compromise in the quality of supervision.	
D3.4	**Participation of PhD students in the outputs**
PhD students appear to be well-mentored and take part in several publications, as would be expected from good-quality supervision.	
D3.5	**Participation of the team in master or bachelor studies**
The teaching of a half-dozen courses per semester, at both under- and post-graduate levels at Prague universities underscores this commitment.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
A standing/regular intensity of a half-dozen courses per semester is certainly demanding and impressive on any team’s time and energy.	

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

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
The commission noted particularly Prof. Palatinus‘ Science-Week activities and also wider-group activities for schoolchildren – which are believed to be very important. It is also good to see some nice press-release activity about the high-profile electron-crystallography. work.	

D4.2	Publishing activities and its quality
This is good, with popular-science writings detailed. Perhaps authorship of some op-ed pieces in the popular media might consolidate this positive start.	
D4.3	**Participation in professional organisations in the area of research and development**
This is good – journal editorship, ECA & IUCr panels/commissions, review panels for Czech Science Foundation and Czech Government, foreign expertise on ANR.	

Other comments of the commission:
A dedicated group boasting some world-class outputs, featuring a good balance of methodology development and applications, with a keen eye towards knowledge transfer, outreach, education and training.

12. Semiconductors

Strengths:
1. Robust quality of research, with good journal output
2. Excellent domestic and international collaborations
3. Impressive momentum in the pipeline of new discoveries
4. Growing breadth of activities, such as also in the biological space
5. Hosting prestigious workshops, conferences and symposia

Weaknesses:
1. Data-storage challenges
2. Upcoming crop of retirements

Opportunities:
1. Expansion of some op-ed pieces in outreach activities
2. Further funding from, and interactions with, Horizon Europe
3. Prospect for positive engagement with AV21 goals

Threats:
1. Difficulty in attracting students, especially for PhD work

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

H1.1	Quality of selected outputs of Phase I
The quality of the outputs is strong and solid, as exemplified by the Phase-I comments; there, the earlier evaluation appears to have been attentive and appropriate.	
H1.2	**Contribution of workers on the outputs reached**
It is clear that there is a widespread effort from across the wider team in a variety of different sub-themes of research, including quantum dots, high-speed scintillators and quantum transport (with impressive effect in low-dimensional and biological systems).	
H1.3	**Quality of all outputs and results**
The quality of research is robust, with solid journal performance. A particularly prominent area lies in major advances in high-speed scintillators, where we consider the group to be world-leading in terms of both methodology and applications. The relative success of the LABONIT project is also highly welcome.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The technical developments of magneto-transport and magneto-capacitance underpinning the MOVPE efforts are very impressive, and this constitutes an area of rather striking international progress and leadership of the group.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Collaborative efforts with Crytur and On-Semiconductor, including joint patents, are seen as a striking example of industrial co-operation. There are many collaborations with other research institutes and universities all over the world.	

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's research addresses many pertinent societal questions and issues, such as functional materials and semiconductors – all huge 21st-century issues to drive the knowledge/information economy.	
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 strong industrial interactions with On-Semiconductor and Crytur with several joint patents is a great example of advanced knowledge transfer.	
H2.3	**Relation to practice**
There is a good record here with Crytur and On-Semiconductor.	
H2.4	**Participation in AV21 strategy**
This was less discussed, with some cursory mention during the presentation and ensuing Q&A. Still, working with industry and developing joint patents does show AV21-type activities.	
H2.5	**Cooperation with regions of the Czech Republic**
This is strong, within IP itself, and the two industry collaborators (On-Semiconductor, Crytur). The collaboration with Brno, Pardubice, VSCHT Prague is also noted as Czech activities.	

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 commission feels that this team compares quite well with other similar-sized research teams internationally, and is competitive in terms of outputs.	
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 quality of international co-operation is quite good, with, *inter alia*, France, Switzerland, Germany, Greece, Poland, Slovakia, USA and Italy. This covers both methodologies, underpinning theory (e.g., thermal physics), as well as applications.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
This is very good indeed: the prestigious FQMT conference series is renowned for its quality, so to organise three is a real coup! There are also many awards and some very notable invited lectures. The membership of several members on international committees is impressive (*e.g.*, evaluation panels, advisory boards, etc).	

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 planned directions are in line with overall CAS and IP goals, continuing with the structural strengths in scintillators and intriguing new advances in enabling novel methods of magneto-capacitance and transport.	
D2.2	**Assessment of the previous research objectives and their achievement**
The 2015-19 goals were well-placed, and they were realised, by and large. The operation of the new lab, starting in mid-2015, has really facilitated the hoped-for rapid progress during that period, with really fast nitride scintillators and nitride-based HEMTs.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
We consider that these have been well managed – especially the management of change manpower-wise (with the entry of four new postdocs into the team), and consolidation of inter-team collaboration, which is the case of joint activity with Team 4 (Functional Metal Materials and Thin Films). The development and conduct of the LABONIT project has been important, as well as handling effectively the required age-structure transition.	
D2.4	**Success in receiving grants**
This has been strong, especially at H-2020 level, *e.g.*, ASTRANIT and LNSM.	
D2.5	**Adequacy of instrumental equipment**
The infrastructure is adequate, although there are data-storage needs which became apparent for the needs of the team, as Q&A during the presentation revealed. Still, this appears to be manageable.	
D2.6	**Effectiveness of management**
Management seems to be effective. The upcoming crop of retirements will be a key area in which strong and effective management will be important, as there is a ‘Velvet‘ gap of middle-aged staff.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The expansion of research-activity portfolio in 2015-19 (ASTRANIT, LNSM, LABONIT) has been well managed, by and large, as are such forward-looking ambitions (e.g., nitride-based heterostructures with ToF-PET playing an important role, and EFP and other magneto-capacitance developments. Despite the ‘new blood‘ into the group, there could have been more said in relation to handling the upcoming series of retirements and addressing age structure, although the management of that in 2015-19 appears to have been done relatively adeptly.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The IP as a whole has been making strenuous efforts in this regard within its power, such as allowing work-at-home one or two days per week, which is particularly helpful for young parents (particularly mothers). On gender *per se*, the team’s balance is not particularly out of line with that of IP, and it has improved somewhat in 2015-19.	

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
This is strong, with good collaborations with Russia, USA, France, Switzerland. The teaching at a variety of universities is also solid.	
D3.2	**Effectiveness of joint research centres**
The LNSM and LABONIT projects demonstrate impressive outcomes from such joint research centres.	
D3.3	**Success rate in supervision of PhD students**
This is reasonable, bearing in mind the well-flagged difficulty in recruiting them. There does not appear to be any compromise in the quality of supervision.	
D3.4	**Participation of PhD students in the outputs**
PhD students appear to be well-mentored and take part in several publications, as would be expected from good-quality supervision, also with strong industrial engagement – an unusual aspect of PhD training.	
D3.5	**Participation of the team in master or bachelor studies**
The research supervision and ongoing teaching of several courses per term, at both under- and post-graduate levels at several universities underscores this commitment.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
A standing intensity of several courses per term is demanding and credit is due to the team for maintaining this level of commitment.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
This is very good, especially with TV and public programmes. We are glad to see a good level of school visits and open-day interactions, and appreciate a good deal of efforts with handicapped children.	
D4.2	**Publishing activities and its quality**
Publishing activities are appropriate. Perhaps authorship of some op-ed pieces in the popular media should be considered.	

D4.3	Participation in professional organisations in the area of research and development
Members of the team are part of programme committees, editorial boards, and the FQMT organising committee.	

Other comments of the commission:
A good, well-rounded group with some internationally prominent outputs, with a good balance of methodology development and applications, and a keen eye for patenting, innovation and industry engagement. Well-managed, also.

13. Magnetics and Superconductors

Strengths:

- Solid standing on magnetism and magnetotransport phenomena
- Experimental techniques have been improved
- Good chances for cooperations across departmental borders
- Team already started the rejuvenation process, also keeping the gender balance in mind

Weaknesses:

- With a limited team size a (maybe too) wide range of topics is still addressed
- The range of topics has been somewhat reduced, but new topics have been adapted
- Although reasonable, the publication output could be still improved in terms of high-impact journals

Opportunities:

- Magnetism and magnetic nanoparticles for biomedicine can be expected to be a growing topic
- 2D materials and their magnetism appear to be a promising field with potential international impact

Threats:

- Any expansion of the scientific activity of the team may require additional personnel. This needs to be carefully evaluated.

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

H1.1	Quality of selected outputs of Phase I
The average scientific quality of the evaluated outputs – as compared to other teams – may be seen as solid and ranges from good to very good, but not excellent (highest number of contributions in quality group 3, none in quality group 1). It appears that the scientific output can still be improved in the future.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of the team members to the outputs is only average (17% according to the phase I evaluation.	
H1.3	**Quality of all outputs and results**
There is an extensive list of publications, to the larger part addressing aspects of magnetism and magnetotransport, with a smaller part on superconductivity. However, most of the outputs fall again in the range of Q2 and Q3.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team is strongly oriented to fundamental physics. • thermoelectricity studies for energy conversion (*) • spincaloritronics in oxide materials • demonstration of pressure-induced spin-crossover photomagnets • dedicated preparation of magnetic nanoparticles with applications in MRI and biomedicine (*)	

Some of the results (*) have also been developed towards applications	
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 has several activities on magnetic nanoparticles for medical applications (partially covered by patents and projects) and on waste-heat recovery by thermoelectric generators. These outputs may be of 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**
Significant impact by relevant patents and providing a highly specialized knowledge base for partners in industry and science.	
H2.3	**Relation to practice**
There is a link to several industry partners in both biomedicine and thermoelectrical energy conversion for heat recovery.	
H2.4	**Participation in AV21 strategy**
The research of the team is in line with the AV21 strategy.	
H2.5	**Cooperation with regions of the Czech Republic**
There is some cooperation with Czech universities and automotive industry (Skoda), but no direct cooperation with regions of the Czech Republic.	

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 compares well with leading groups in other places, e.g. those in the MPG or WGL societies or similar university institutions, although there is still room for improvement.	
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 has numerous national and international cooperations, mostly in Europe, but also in Japan, which is also well-documented by joint publications.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Some members of the team were involved in organizing domestic conferences.	

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 planned consolidation of the scientific efforts towards

- research on longitudinal and transverse magneto-thermoelectrics
- exploration of novel 2D magnetic structures in vdWaals trihalides under extreme conditions
- magnetic nanoparticles with plasmonic components
- molecular systems with exotic magnetism

appear realistic, in particular, if the limited size of the team is taken into account. They can be expected to lead to interesting results on an international level.

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

The team addressed most of the previous research objectives and in most cases reached the planned goals. Following the recommendations of the last review (D2.3) the team also reoriented the research to more contemporary topics of magnetism. The activities are scientifically justified and on a good way, but due to the short time, high-level results are still missing yet.

D2.3	Assessment of implementation of recommendations from past evaluation

The team answered the recommendations of the past evaluation by recently restructuring the team and adopting several modern topics of magnetism. They actually shifted the weight from superconductivity further to magnetism. The outcome of these changes may increase the international competitiveness, but is not clearly visible yet.

D2.4	Success in receiving grants

The team is successful in achieving grants from institutions and industry.

D2.5	Adequacy of instrumental equipment

The instrumental equipment is of high quality by international standards.

D2.6	Effectiveness of management

Given the current team organization in several laboratories, the management strategy appears to be adequate.

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

The management has been able to keep the number of team members in the same range over the last 5 years, thereby also promoting young researchers and very recently also recruiting new team members (postdocs). Moreover, it is also putting effort in training activities.

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

The team has also improved on the gender issue, although this is generally a problem in established fields in physics. The number of females reaches now between 20-25% of the entire group.

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 cooperation with national and international universities appears to be quite established.	
D3.2	**Effectiveness of joint research centres**
The team is part of the MGML activities and significantly uses the METACENTRUM.	
D3.3	**Success rate in supervision of PhD students**
Given the limited size of the team the number of defended PhD theses (5) is relatively high.	
D3.4	**Participation of PhD students in the outputs**
The PhD students contributed to a large number of manuscripts published in scientific journals with impact factor.	
D3.5	**Participation of the team in master or bachelor studies**
The team is also involved in BSc and MSc studies, but the number is smaller than that of the PhDs.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Two members of the team (Hejtmanek, Knizek) had several teaching courses on the MSc level, and some fewer on the PhD level, highlighting a functioning cooperation with Prague 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 team was involved in several activities, such as the Open Days of the CAS, or public lectures.	
D4.2	**Publishing activities and its quality**
The publishing activities of the team are on a good qualitative level.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members participate actively in several domestic and in international professional organizations including conferences dedicated to research and development.	

Other comments of the commission:
None.

14. Optical Materials

Strengths:
This team conducts several multidisciplinary research activities at both fundamental and applied levels and often within some well-established long-term international collaborations. Very good technical support and success in linking together basic and applied research. Project-oriented research activities guarantee a high level of outputs and sufficient funds for all activities The team is successful in attracting numerous MSc and PhD students to its research projects.

Weaknesses:
The team is in a need of some more stable institutional funding, since most of its projects are supported by grants. Eventual repairs may cause substantial delays in research activities. The available laboratory space is rather small.

Opportunities:
Transfer to Slovanka campus in the Framework of the Solid21 project, planned transfer within the 6-12/2021 period

Threats:
Fragile situation regarding sustainability since many of its activities have to be supported by grants, and not by the institutional funding.

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

H1.1	Quality of selected outputs of Phase I
The majority of the selected outputs are internationally excellent and some are world leading.	
H1.2	**Contribution of workers on the outputs reached**
The contribution of staff is significant and includes also a contribution from graduate students supervised or co-supervised by the staff.	
H1.3	**Quality of all outputs and results**
The quality of outputs is very solid, with many journal papers.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The research on technology, design, characterization and applications of diamond and diamond-like materials, scintillators materials and thin films looks particularly promising from the point of view of fundamental science and practical applications.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Many papers result from well-established collaborations in the Czech Republic and from foreign countries such as China, Japan, UE, Russia and others.	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
A number of application-minded projects, especially from the Technological Agency of CR are assuring efficient long-term collaboration with several national companies: Praemium Academiae prize awarded to M. Nikl for the 2014-2019 period. Institutional Solid21 project awarded from the Operational Program (Science, Research, Education) of EU Structural Funds for the period 7/2018-6/2023 Several group members give lectures in several universities and supervise graduate students. A good strategic collaboration exists with several compagnies and a successful technology transfer has been accomplished. In addition to many publications, several international patents have been awarded in Korea, China and the USA.	
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 knowledge transfer looks good, but it is hard to comment on its impact on social sciences and humanities.	
H2.3	**Relation to practice**
The practice related to handling the intellectual property and obtaining patents is appropriate.	
H2.4	**Participation in AV21 strategy**
N/A	
H2.5	**Cooperation with regions of the Czech Republic**
The collaboration involves many CR universities and several industrial companies.	

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 team compares very favourably and is competitive in relation to other similar teams on the international scene.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
These collaborations are excellent and the team often assumes a leading role in many of them.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The team members have participated in many such activities, which included also about 30 invited talks at conferences.	

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 follows a well thought out strategy of use of advanced technology to manufacture a variety of composite, thin films and nanostructured materials, through theoretical modelling, experimental verification and testing of required functionalities, in some cases with close collaboration with industrial partners.	
D2.2	**Assessment of the previous research objectives and their achievement**
All the targets from the 2015-2019 plan have been met and some new activities have been additionally developed.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations from the last evaluation, in particular the improvement of technical and scientific infrastructure, and ensuring the availability of highly qualified research personnel, have been well implemented. However, some labs need more space and some groups need more PhD students to be involved in their research.	
D2.4	**Success in receiving grants**
The group is very successful in this area, with about of 70% of its funding going from the grants.	
D2.5	**Adequacy of instrumental equipment**
The equipment and instrumentation systems available to the group are of high quality and comparable to the international standards.	
D2.6	**Effectiveness of management**
The management looks solid and is based, among other things, on generating a synergy between the smaller groups of people involved in competitive multidisciplinary research activities.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The age structure should be carefully monitored, since a number of workers are approaching retirement, and there is some lack of “experienced researchers” in the age group from 50 to 60 years.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The gender issues are well taken care of, with about 38% of the workforce being women.	
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 team members were involved in many collaborations with universities in CR and abroad, in such countries as France, Italy, Austria, USA, Japan and Malaysia.	
D3.2	**Effectiveness of joint research centres**
The team participates in the Joint Laboratory of Polymer-based Nanofibers with Czech Technical University.	
D3.3	**Success rate in supervision of PhD students**
In total 24 of PhD students were supervised and co-supervised, with 7 successfully having defended their theses during the period of evaluation.	
D3.4	**Participation of PhD students in the outputs**
This is a normal practice. Therefore, many PhD students have joint publications with the team members.	
D3.5	**Participation of the team in master or bachelor studies**
In total 13 of MSc and BSc students were supervised by the team members and all of them successfully defended their theses during the period of evaluation.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
This is very good, since during the evaluation period the team members gave 64 semestral courses at BSc level, 50 at Masters level and 24 at the PhD level, at various 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 outreach activities of the group are adequate and include popularization lectures, radio broadcasts, lectures for schools and laboratory visits.	
D4.2	**Publishing activities and its quality**
Several articles and brochures were prepared for the public regarding the activities conducted by the group.	
D4.3	**Participation in professional organisations in the area of research and development**
Several team members are active in participating in scientific commissions like for instance Czech Science Council, editorial boards of scientific journals, and PhD committees at different universities.	

Other comments of the commission:
None.

15. Classical and Quantum Optics

Strengths:

- Joint Laboratory of Optics (JLO) with Palacký University Olomouc:
  - Joint infrastructure from both partners
  - Access to the modern and well-equipped instrument park of the university.
  - Easy access to teaching, academic professional growth,
  - good access to talented candidates for newly opened scientific positions
- Balanced mixture of fundamental and applied research.
- Successful in obtaining grant support from national sources

Weaknesses:

- The joint workplace with the university causes relatively large overhead activities, larger than at an average department at the Institute of Physics or a university:
  - administration of the team and the administrative rules
  - IT systems of both institutions raise different requirements and systems are partially incompatible.
- Moderate success in obtaining grant support at the international level.
- Unfavourable gender structure
- Foreign JLO members only via university

Opportunities:

- Increased activity in quantum information processing and quantum correlations
- Extension of collaborations for optical detection in particle physics
- Optical non-contact techniques in biophysics
- Multifunctional thin films

Threats:

~50 % of budget (unassured) grants (Joint Laboratory of Optics)

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

H1.1	Quality of selected outputs of Phase I
The quality of outputs is very high to outstanding. They were all published in very highly ranked peer-reviewed Journals (Physical Review, Physical Review Letters, Scientific Reports, NPJ ...)	
H1.2	**Contribution of workers on the outputs reached**
Th contribution of team members from the FZU was very high: > 50 % of JLO contributions, substantial in international cooperations.	
H1.3	**Quality of all outputs and results**
The results in the main fields of the team: – Quantum Optics (quantum information processing), – Applied Optics (non-standard optical elements), – and Measurement Methods, Layers, and Surfaces were of high quality and international standard.	

H1.4	The most valuable discoveries and findings in the fields, their importance for the field
Quantum gates and quantum routers, using quantum superposition states and controlled quantum bits; quantum machine learning, quantum cloning, hyper-entangled multi-level states, propagation of quantum correlations. Low scatter mirrors, collaboration in operation of the Pierre Auger Laboratory, the Cerenkov Telescope Array, FAST (Fluorescence detector Array of Single-pixel Telescopes) Nanoindentation with acoustic emission microscopy.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Pierre Auger Observatory, Cerenkov Telescope Array, FAST (Fluorescence detector Array of Single-pixel Telescopes), CERN	

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

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Optical technologies for the industry (Meopta-optika, Mubea Spring Wire, Hella) and for science (mirrors for LHCb, RICH RCUCH detector)	
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**
N/A	
H2.3	**Relation to practice**
see H2.1	
H2.4	**Participation in AV21 strategy**
N/A	
H2.5	**Cooperation with regions of the Czech Republic**
JLO located in Olomouc. Apparently, little interaction with other regions of CR (including Prague)	

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 is at eye level with similar international 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**
Strong international collaboration engagement (cf. H1.5) in CERN, PAL, CTA, several international universities.	

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
Several team members serve in Czech Science Foundation and Ministry of Education; reviewers for international grant agencies and scientific journals; board members of national and international commissions. Organization of 8 national and international conferences and workshops. 13 international invited talks, 3 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 present activities are well in line with planned future research directions (see also “Opportunities“)	
D2.2	**Assessment of the previous research objectives and their achievement**
The previous research objectives have been fully met	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations from the past evaluation (maintaining the high-quality level of scientists and engineers; invest even more into education) have been fully implemented. However, the second part seem to be mostly met by the university part of the JLO.	
D2.4	**Success in receiving grants**
The JLO has been very successful in receiving national grants. There was only moderate success in international grants.	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment is (also because of the collaboration with UPOL) very good and adequate.	
D2.6	**Effectiveness of management**
Despite the complicated structure (Academy & University) the management is adequate and effective.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The professional structure appears adequate, with a sound balance bewtween scientific and technical staff.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Very poor female contribution.	
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 team is very active in international collaborations, both in direct bilateral cooperation with 7 universities/research institutes world-wide and in large cooperations (cf. H1.5)	
D3.2	**Effectiveness of joint research centres**
The team is part of the JLO (with UPOL). All activities are in the framework of this joint institute.	
D3.3	**Success rate in supervision of PhD students**
4 team members served as supervisors, 2 as consultants for PhD students. In the evaluation period, 7 PhD Theses were successfully defended.	
D3.4	**Participation of PhD students in the outputs**
The participation for PhD students in the outputs is respectable: about 30 % of the outputs were co-authored, in 2/3 as first authors.	
D3.5	**Participation of the team in master or bachelor studies**
As a consequence of the tight connection with UPOL, the team was very active in the supervision of BSc and MSc studies: 17 BSc and 5 MSc Theses were defended.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
As a consequence of the tight connection with the UPOL university, the team was very actively involved in university teaching, far above-average.	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Very active annually: summer schools, open days, science workshops, nights of scientists, Olomouc Physics Kaleidoscope, Miniconferences, “Trips to microworld“ for young people/schools, publications, videos excursions, popular lectures, contributions on Facebook, Youtube	
D4.2	**Publishing activities and its quality**
The publishing activities were very high (250+/a including large cooperations (a); ø 35/a without large cooperations (b)) and well accepted (h-index 108 (a) resp. 40(b))	
D4.3	**Participation in professional organisations in the area of research and development**
Several team members serve on several panels and boards in CZ, as reviewers for international grant agencies and scientific journals, journal board members, international committee members.	

Other comments of the commission:
None.

16. Low-Temperature Plasma

Strengths:
- The team has a lot of skills in experimental physics in the field of plasma physics, plasma diagnostics and plasmatic thin film deposition and surface treatment.
- The team has the ability for cooperation with industrial partners on applied research or on contractual research.

Weaknesses:
- The need for cooperation with external people in the field of modelling of physical processes in plasmas and in plasma deposited films.
- Low gender diversity given by the lack of qualified/available female researchers in the plasma engineering field.
- The links to industry industry could be further improved (the team is located between the fields of material physics and engineering and the step into industrial technologies can be done in the near future).
- A weakness is the missing exchange of young and talented students and researchers.

Opportunities:
- The team can involve Ph.D, BSc. and MSc. students in its research program, thanks to starting cooperation with universities.
- The team has the possibility of cooperation with other institutions and universities at the international level.

Threats:

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

H1.1	Quality of selected outputs of Phase I
From selected outputs (23): 5 outputs were in 1st quartile, 13 in 2nd quartile, and 4 in 3rd quartile. These 18 outputs belonging to the highest outputs. The LTP team was evaluated (Phase I) within 15 another teams of the field Materials Engineering. Average rating was 2,83 that resulted in the 15th position among the 16 teams. The department performs nationally and also internationally recognized research in the broad field of plasma processes. The outputs of Phase I are below the average quality (within the field Materials Engineering). The scientific publications are in appropriate journals of the field.	
H1.2	**Contribution of workers on the outputs reached**
The team members (researchers, technicians) contributed in reasonablely high amounts, ranging from 20 to 100%, to the outputs (it is extracted from the list of publications: 3-8 Outputs_evaluated_within_Phase_I), in most cases from 50 to 70%.	
H1.3	**Quality of all outputs and results**
The list of all outputs and results contains 108 items. Total number of evaluated results was 65. One output was in the top decile, 6 in 1st quartile, 20 in 2nd quartile, 24 in 3rd quartile, and 12 in the 4th quartile. The commission took into consideration that the processes and diagnostics are important ones for plasma applications but they are relatively minor fields in the broad field of Materials Engineering. The main scientific journals with plasma applications do not belong to the top journals in materials science. Therefore these results are temporarily appropriate	

with the transition position of the team (between the fields of material physics and engineering, awaited in the next future) within the whole Institute.

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

Valuable discoveries have been reached and published. They cover the development of methods and processes as

Plasma deposition of semiconducting oxide thin films for photoelectrochemical applications - solar hydrogen production.

Research of complex semiconductor thin films for photoelectrochemical and catalytic or photocatalytic applications (with partners from VSCHT).

New plasma diagnostic methods developed by the team.

Plasma deposition system developed for coatings of inner walls of long metallic and dielectric tubes.

Deposition of functional thin and thick TiO2 films for industrial applications.

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

Societal relevance in engineering and technical sciences primarily means a contribution to the competitiveness of the national economy through applied research in cooperation with industrial partners. In technical sciences a significant part of motivation comes from the application sector. The link to practice is in technical branch of research inevitable and deeply incorporated in any research strategy. In the field of plasma processes the inspiration in research is a mixture of impulses coming from industry, from development, and from basic research. Advaced plasma technologies represent nowadays a key and determining tool in modern technologies of surfaces. Plasma deposition of semiconducting oxide thin films for photoelectrochemical application are very promising technologies, mainly for solar hydrogen production. The particular results (with strong societal relevance) can be seen in several next years.

As the conclusion, the research of the Department of LTP follows the institute mission and has significant societal relevance with contributions in the appropriate fields.

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 most of results of the LTP team is used for technologies of surfaces. The transfer of knowledge into practice is a bit below average (measured by the number of projects). See also paragraph H2.3.

H2.3	Relation to practice

During the evaluation period, the department has demonstrated the following applied research and development (as the relation for practice).

Plasma deposition of semiconducting oxide thin films for photocatalytic solar production of hydrogen.

Research of complex semiconductor thin films for photoelectrochemical and catalytic or photocatalytic applications. Plasma deposition system developed for coatings of inner walls of long metallic and dielectric tubes (for Česká zbrojovka). The number of interactinos and projects should be further increased to fully exploit the potential of the experimental and theoretical facilities and the researchers' capabilities. Mainly the semiconductor industry uses plasma tools which operate on a really high technological level.

H2.4	Participation in AV21 strategy
According to the report and presentation of the team there is no explicit participation in the AV21 strategy.	

H2.5	Cooperation with regions of the Czech Republic
The department cooperates with universities, research institutions and companies in several regions of Czech Republic (South-Bohemia Region, Olomouc Region, Central-Bohemia Region).	

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 researchers of the department perform good research focusing on fundamental knowledge as well as on future industrial application (surface technologies). From the summary graphs reported in concerning the team scientific publications (Phase I), we judge that the team's position in an international context is 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 LTP team maintains a lively and active cooperation with several domestic (Prague, Pilsen) and international universities and firms (France, 2 x Germany, South Korea). The main team tasks in such cooperation are the development of plasmatic deposition systems and plasma diagnostics. These collaborations appear as bilateral and do not lead to external international funding. In the future the team needs to initiate more cooperations in the position of a coordinator and a leader.	

D1.3	Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)
It is mainly the team leader and two other workers who are active in relevant scientific communities on a medium level. The team did not organize conferences and workshops. There has been four invited lectures at international conferences for the team during the evaluation period. Ing. Tvarog was awarded in the project Photogenic science organized by Academic board of CAS.	

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 generally followed the plan for 2015-2019 (5 tasks). The followed directions of	

the Department agree with the planned research directions of the whole Institute (the plasma physics research is the type of long lasting research). The LTP team plan for the period of 2015-19 has been carried out. A detailed vision of the future is described. Theoretical modelling of processes in the plasma will be the new research topic.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previously planned research objectives were assessed and main research directions were followed. Previous research objectives were well selected based mainly on the needs of applications and their achievement has been documented through several relevant publications in journals as well as through some form of cooperations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations from the last evaluation have been taken and implemented seriously. There were 4 recommendations and we can see noticeable progess.	
D2.4	**Success in receiving grants**
The LTP team is successfull in aquiring grants mainly from GACR (5) and partially from TACR (2), MEYS (2), MPO (2) and 1 big projects from the EU. In total about 3 180 kE were received in the investigated period: -- grant projects and programme projects, 12 projects, 3 123 kE, - contractual research, 2 projects, 57 kE, This must be regarded as success (only the number of contractual research projects is a bit lower than some optimum for this team).	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment is good. In this context, the commission admires the capability to built advanced and custom-made equipment to generate and study plasma towards a future specific (mainly plasma) processes. This equipment is a plus for future research activities.	
D2.6	**Effectiveness of management**
This small team appears as well-managed as the Commission is able to judge indirectly from the really good environment for performing of research. It is reported that Mgr. Zdeněk Hubička is leading the team successfully and with great experience, of course very small size of the team may create problems.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The LTP team is a small one (21 employees). It has a stable core of members and is relatively young (median age is 38 years). In the evaluation period, the team was composed on average of 12-13 researchers (out of which are 2 postdocs), 3-5 PhD students (partially employed at IPP), and around 6 technicians. A major generational change was successfully finished before the year 2015. 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. Working hours are as flexible as possible to allow work-life balance especially for female researchers.	

The team lacks sufficient gender balance. An original reason is referred to the minor proportion of women in Physics and Engineering university studies in general as reason for existing misbalance within evaluated physical institutes (as well departments). It is suggested to create and implement a strategy also for the department to achieve gender balance in the medium to long-term in accordance with the policy of the institute (and equal opportunity employer).

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 LTP 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
Cooperation with national (Czech) universities exists on the basis of research collaborations (Prague, Pilsen) and the supervision of PhD students (Prague, Olomouc). Cooperation with universities abroad exists as well (France, Germany). The education of undergraduate and postgraduate students is also the visible part of mutual cooperation. Main teaching activities exist at South Czech University, Faculty of Science (České Budějovice). All these cooperation are on a moderate level.	

D3.2	Effectiveness of joint research centres
The team did not participate in any research centre with universities during the evaluation period.	

D3.3	Success rate in supervision of PhD students
In the period 2015 – 2019 two doctoral students graduated. At present 3 doctoral students are preparing their theses under guidance of Dr. Hubička.	

D3.4	Participation of PhD students in the outputs
Five PhD students are reported, two of them had already finished his/her study and participated on 5 resp. 3 papers. The LTP team believes that the participation of PhD students in the research activities of the team is beneficial for both sides.	

D3.5	Participation of the team in master or bachelor studies
Main pedagogical activities exist at The South Czech University, Faculty of Science (České Budějovice). Three teachers from the LTP team are engaged in teaching of 5 subjects for bachelor studies and 2 subjects for master studies. During the evaluation period, 3 master and bachelor theses could successfully be completed.	

D3.6	Assessment of cooperation intensity with universities in the form of teaching
Teaching activities on a university level are low. Each year, selected lectures within 5 subjects are delivered (by 3 teachers) at the South Czech University, being the only 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
The team takes part in popularization activities, which are on a usual level, such as taking part in Open Door Days, in a Science Fair (Ing. Tvarog and Dr. Dvorakova, a poster, 2017), in a Companies Day for Physics (Dr. Olejnicek, a lecture, 2019), or in the Open Science project of CAS. The team started to cooperate (as one of the recommendations from past evaluation) with the CITT (Centrum pro inovace a transfer technologií). The CITT is responsible for presentation of applied research results to industrial companies in the Czech Republic and abroad. These outreach activities might be intensified towards the popularization of team research. The Commission proposes that the media strategy is to be managed across the whole Institute.	
D4.2	**Publishing activities and its quality**
Several presentations and posters presenting the technical possibilities of the developed low temperature plasma sources were carried out in cooperation with CITT. See also the paragraph D4.1. The Commission can confirm that the publishing activities of this small team are adequate.	
D4.3	**Participation in professional organisations in the area of research and development**
It is mainly the team leader and two other workers who are active in professional organisations (Dr. Hubička, Dr. Čada, and Assoc. Prof. Straňák).	

Other comments of the commission:

Department of Low-Temperature Plasma is small average team within the Institute of Physics. The team certainly has future potential but might need more time and project funds to grow to a more substantial degree. The commission recommends to maintain the efforts in realization high quality research and publishing scientific paper in top journals and in teaching activities as guest lectures at Czech universities as well as abroad. The members of the team should focus to the technological transfer of the obtained scientific results towards the industry to gain a visible societal relevance.

17. Optical and Biophysical Systems

Strengths:
The Team performs interdisciplinary research, which is based on an excellent collection of expertise from physics, chemistry and biology. There is an amazing gender balance (~50%), which is outstanding in engineering and physics. They have very good instrumentation to support their research. Teaching activity is strong.

Weaknesses:
The Committee agrees that recruiting good technicians and keeping students as for continued research would also be key points. The grant structure of the Team is exclusively domestic. International grants would also be desirable.
Opportunities:
Relatively young team. The level of the obtained results and the expertise in the Team should form a basis for acquiring international grants, too.
Threats:
The low level of salaries in research (a problem common not only in the Czech Republic but over Eastern-Central Europe) also hinders hiring the best quality technicians. Extension of income from grants could alleviate the problem.

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

H1.1	Quality of selected outputs of Phase I
The department accomplishes internationally recognized research in the field of optical and biophysical systems. Their main results are on perovskite oxides, interaction of nanoparticles with cells in pulsed magnetic field and medical possibilities of cold plasma. On the basis of Phase I evaluation, they are the 3rd in the 24 teams that Committee 7.1 visited.	
H1.2	**Contribution of workers on the outputs reached**
The dominant fraction of their work is done in both domestic and international cooperation. The majority of the publication comes from members of this team as corresponding author.	
H1.3	**Quality of all outputs and results**
Very high quality outputs (127 papers in IF journals, 4 in the first category, 1 book and 3 chapters). The outputs selected for phase I are concentrated in the first decile and quartile, while the rest of the publication is uniformly distributed in quartiles 2-4.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Epitaxial thin films of perovskites produced properties, unprecedented in bulk forms, leading to excellent performance of bottom-to-top capacitors. Successfully applied non-thermal plasma for both disinfection and to foster healing. By analysing the molecular mechanisms of functionalized nanoparticle interaction with living cells, they successfully used SPIONs that can be guided to pre-selected organs in the body for medical treatment.	
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
The research in the Team is in perfect harmony with the mission of IP and CAS and applies physical knowledge also to biological systems with medical outlook. Research in the field of biomedical technologies is of high social 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 is one of the initiators of the MATCA centre, which provides contact to the industry and can ensure fast access to financing for high risk / high gain industry related projects.	
H2.3	**Relation to practice**
Very good practical application of their results. The Team not only protected their IP in plasma instrument for medical application but also had pilot test in several cooperating veterinary clinics. Their biosensors are tried by the Czech Police. Strong cooperation with industrial partners (15 applications). Their industrial partner CARDAM started constructing automatic mass testers for COVID detection.	
H2.4	**Participation in AV21 strategy**
The Team did not report participation in Strategy AV21.	
H2.5	**Cooperation with regions of the Czech Republic**
Good cooperation with Czech institutions (especially in Prague region).	

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’s researchers accomplish very good basic research with applications underway.	
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 cooperation of the Team with both domestic and international (mainly Finnish and other European) partners appears in both formal activities (COST Action) and in common publications in excellent scientific journals. The role of the Team in such cooperations was showing that non-thermal plasma triggers apoptosis-like cell death in bacteria, analysing the molecular mechanisms of functionalized nanoparticle interaction with living cells and growing epitaxial perovskite films with properties not found in bulk forms. Very good international cooperation (Spain, France, Germany , Finland, Russia, Rumania, the UK).	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The members of the Team organized one smaller meeting and participated in the organization of 3 workshops. The gave 16 invited lectures and obtained prestigeous awards (1 Lumina Quaeruntur fellowship + 2 Otto Wichterle Award of CAS). This is quite	

good for a group of size ~18 FTE.

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 followed directions agree with the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previous research objectives were followed with increased emphasize on biological relations of physics in accordance with recommendations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The Team sucessfully followed the recommendation that they should put even more focus on novel biomediccal technologies. In line with this requirement, they created two new laboratories and progressed well into this interdisciplinary, multdisciplinary area.	
D2.4	**Success in receiving grants**
Good support by Czech and European grants (16 projects and grants). The Team is successful in receiving grants from GACR, MEYR and TACR. In total they collected 1.36 Meuro from grants. OP VVV grant also played and important role in improving the infrastructure.	
D2.5	**Adequacy of instrumental equipment**
The Team owns state-of-the-art equipment, like ultra-fast super-resolution microscope, cytometer or 3D printing. The development of their own instrumentation (like PLD system) is also to be praised.	
D2.6	**Effectiveness of management**
The department is effectively managed. They also get efffecctive support from the institute, which owns European Commission's HR Excellence in Research Award.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The professional composition of the Team well corresponds to its interdisciplinary character. The age structure is well balanced, most of them between 25 and 50, peaked between 35-40. A few senior researchers are also present to surpass their knowledge to the younger generation.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Work-life balance conditions are well regulated at the institutional level (maternity leave, part-time employment). The gender balance among scientists in the Team is 1/3 female, however 80% of their students are girls, which is outstanding in an institute of physics.	
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.	

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 group has informal cooperations with one domestic and two European universities.	
D3.2	**Effectiveness of joint research centres**
The Team shares equipment and deposition laboratory with CTU, Prague and have a large number of common publication from the joint work.	
D3.3	**Success rate in supervision of PhD students**
They supervised 6 PhD students and 6 PhD theses were successfully defended in the last period, which is good, especially if the number of PhD students will be continuously maintained.	
D3.4	**Participation of PhD students in the outputs**
The PhD student regularly participate in the research outputs, both as first authors and as co-authors. Two of them even won prize with their publication and a poster prize was also given to a student.	
D3.5	**Participation of the team in master or bachelor studies**
The Team supervised 8 bachelor and 8 master theses. Out of these, 7 bachelor and 4 master theses were defended in the examined period. This gives good chance for recruiting new PhD students.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Teaching activity of the Team concentrated in CTU FBMI. They gave a very high number of lectures in bachelor level and a high number of lectures at master level. Alltogether they spent more than 2000 hours with lecturing. Creation of extended online course (with cooperation from the USA) is also an outstanding activity of teaching.	

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 active in science popularization. They participate in Open Days, give lectures in Prague Planetarium and in Journal Club. They also participate in science fairs.	
D4.2	**Publishing activities and its quality**
In addition to the excellent publishing activity in scientific journals, they also contributed to science popularization by writing a book popularizing biophysical research.	
D4.3	**Participation in professional organisations in the area of research and development**
Six members of the team are active in scientific commissions, panels, scientific councils and editorial boards, which is good.	

Other comments of the commission:

The committee recommend that they should continue their successful research in their multidisciplinary field. They should increase effforts in attracting students and researchers also from abroad. Increased efforts in applying for international grants would also be desirable.

18. Fabrication and Analysis of Functional Materials

Strengths:
The department is a young perspective team with skillful and experienced researchers. The department is focused on basic science and is flexible for different advanced research directions. The team is very active in knowledge and technological transfer. The department is equipped with excellent high – tech processing units and characterization/testing equipments.

Weaknesses:
Wide range of the research topics for the number of researchers. The excellent high – tech processing units and characterization/testing equipments need to upgrade which requires significant financing.

Opportunities:
The good cooperation with Universities can help them to increase the steady student inflow and increased number of PhD students. The attractive research areas and the excellent research equipments can help in importing young and middle – aged scientists from middle – European countries and to strengthen the research potential.

Threats:
Possible funding problems in post-covid situation. Possible generation problem connected with the key senior researchers of the department.

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

H1.1	Quality of selected outputs of Phase I
From selected outputs (34) of the department for Phase I there are 5 outputs belonging to the highest outputs. In the field of Materials Engineering between the 16 evaluated teams they are below the average in the productivity of teams in world leading outputs per FTE and are around the average in internationally excellent outputs.	
H1.2	**Contribution of workers on the outputs reached**
In the field of Materials Engineering between the 16 evaluated teams they are below the average in the productivity of teams as regards the World – leading outputs and internationally excellent outputs per FTE taking into the consideration the fractional counted and corresponding author calculation, too.	
H1.3	**Quality of all outputs and results**
From outputs (141) 5 outputs were in top decile, 15 in 1st quartile, 43 in 2nd quartile and 38 in 3rd quartile.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Many valuable results have been reached/published during the evaluated period which are important for the research field, e.g.: Fabrications of highly sensitive gas sensors; Development of polycrystalline diamond coating for protection of Zr cladding surface against corrosion in water cooled nuclear reactor; Development of new PVD technologies and in-situ plasma monitoring; Understanding the domain formation in Graphene monolayers;	

Development of nanoparticles for bio applications, etc.

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 research of the department follows the Institute mission and has significant societal relevance with contributions in the following fields: Liposomal particles as drug carriers in vaccine; Protection of Zr tubes against corrosion in hot steam reactors; Precision multifunctional coatings in vacuum and microwaves devices, etc.	
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 department is very active not only in reaching good scientific results but also in strong knowledge transfer into the practise and society.	
H2.3	**Relation to practice**
The positive relation to practice is documented by partners from the Czech Republic and abroad as: TESLA Electrontubes s.r.o., Czech company Bioveta, Tesla Blatna a.s. etc.	
H2.4	**Participation in AV21 strategy**
The department participating in AV21 – New materials based on metals, ceramics and composites.	
H2.5	**Cooperation with regions of the Czech Republic**
The department cooperates with universities, research institutions and companies in many regions of Czech Republic as VŠB Ostrava, Univ. Pardubice, etc.	

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 evaluated department is good quality in comparison with 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**
The department is involved in many high quality international and national cooperations as: Faculty of Medicine and Faculty of Mathematics and Physics, Charles University in Prague, University of Wyoming, USA and University College London, UK;	

Institute Lumiere Matiere, University Lyon, France; Institute of Physics, University of Tartu, Estonia.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The department members are very active in scientific community activities - organizing of conferences and workshops, invited lectures, awards, e.g.: Ass. prof. I. Kratochvílová, Editorial board Scientific Reports, Nature Publishing; Prof. Jindřich Musil Editorial board Vacuum, Elsevier; Ján Lančok, Ph.D. Editorial board member Nanomaterials, MDPI; Jan Honolka, member of the com. Annual Workshop of the International Helmholtz Research School for Nanoelectronic NetworksNanoNet international workshop 2016, etc.	

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 followed directions fully agree with the planned research directions.	
D2.2	**Assessment of the previous research objectives and their achievement**
The previously planned research objectives were assessed and the main research directions are followed or partially intensified for very promising research directions.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The recommendations after the last evaluation have been taken seriously and there were actions to implement them, e,g,: they started new research funded by GAČR and TAČR agencies the research is now focused on materials, such as diamond coatings, thin film chemiresistors, 2D materials and Heusler alloys, etc.	
D2.4	**Success in receiving grants**
The department is very successful in aquiring grants as: GAČR: 16, MEYS: 5, TAČR 3; MPO 1, OP VVV SAFMAT, Participation in OPVVV Solid in Research Activities in Plasma Technology and Nanoparticles for theranostics.	
D2.5	**Adequacy of instrumental equipment**
The department is equipped with excellent equipments as STM, photoemission microscopy (PEEM), photoelectron spectroscopy (ESCA), etc.	
D2.6	**Effectiveness of management**
The department is efficiently/strategically managed by a small board consisting of the leader of the 3 groups. Checking of the team's functions and approving the scientific program are the responsibility of the team board. One of the most important roles of the team board is formulation of an optimization work plan, so that the maximum capacity of particular workplaces is ensured.	
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 department is balanced enabling senior researchers to pass their	

knowledge and experience to the younger generation. There is a problem with the researchers with age between 55 to 65. Attention is paid on vertical mobility of researchers, which is governed by the rules of attestations within FZU. After completing the doctoral study, attention is also paid to young researchers at the beginning of their scientific career. The institute supports their horizontal mobility in framework of 6-month internships at foreign workplaces financed from project Mobility and National susceptibility program (MEYS).
D2.8 Creating work-life balance conditions, assessment of approach towards possible gender issues
Currently 6 out of 25 members of the team are women.
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 departments is very active in collaboration with universities on national and international level, e.g.: An effective method of protection of zirconium alloys by PCD was designed by experts from FZU, the Faculty of Mechanical Engineering of the Czech Technical University and Westinghouse (Nuclear Fuel Division, Westinghouse Electric Company, USA); Research in chemical gas sensors is performed within the frame of an intensive synergetic collaboration with the University of Chemistry and Technology (UCT), etc.
D3.2 Effectiveness of joint research centres
N.A.
D3.3 Success rate in supervision of PhD students
During the evaluation period 5 PhD and 3 DSc thesis was defended.
D3.4 Participation of PhD students in the outputs
The PhD students participated very significantly in the outputs, e.g.: Mgr. M. Golan, Ph.D. - awarded the Best poster at the Society for Low Temperature Biology Meeting: “Complex description of cryopreserved cell nuclei defects by immunofluorescence microscopy: DNA lesions, chromatin decondensation, nuclei membrane ruptures”; Ing. Eva Marešová, realized her Ph.D. study in a long-term cooperation with the University of Chemistry (VSCHT). She focused on the fabrication of the inorganic and organic thin films for chemical sensors and on the optical properties of thin films.
D3.5 Participation of the team in master or bachelor studies
Several bachelor and master students were incoorporated into the research at the department.

D3.6	Assessment of cooperation intensity with universities in the form of teaching
Supervision of students – bachelor: 5, master: 8 and doctoral: 5.	

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 has good plan for media strategy and activities in the area of research popularisation.	
D4.2	**Publishing activities and its quality**
The department has been regularly involved in publishing activities with high quality, e.g.: Presentation for public in frame of „open doors“: “Materials and technology for 21st century” - focused on technologies for thin fabrication, characterization and applications; Surface characterization by electron spectroscopy (XPS) and electron microscopy technique utilizing unique device NanoESCA; Team invention of nuclear fuel tube protection against high temperature corrosion by polycrystalline diamond coating was appreciated by society and presented in Czech TV, radio, Czech and international newspapers and magazines, etc.	
D4.3	**Participation in professional organisations in the area of research and development**
The staff of departments holds leading positions in different international research networks and committees, professional organisations, and evaluation panels.	

Other comments of the commission:

The commission recommends to increase the efforts in realization high quality research and publishing scientific paper in top journals mainly with the corresponding author from the department. The commission recommends to maintain or even increase the teaching activities as guest lectures at Czech universities as well as abroad. With the aim to solve the generation problem, the department should attract students and young researchers from other countries together with highly qualified experts to improve the research potential of the department. To solve problems concerning the up-grading of the excellent devices the department have to be more active in receiving European grants in addition to Czech grants, too.

19. Laser Interactions and Chemical Physics

Strengths:
- PALS facility
- Wide variety of interaction parameters, i.e., wavelengths ranging from infrared radiation to x-rays, various pulse durations of nano-, pico- and femtoseconds, intensities reaching a level of 1019 W/cm^2, repetition rates from single shot exposure to MHz trains of laser pulses
- Physical interactions and chemical consequences
- Experimental and theoretical studies on both photons and charged particles interacting with matter
- Effective collaborations with other disciplines, e.g., physical chemistry, astrobiology, solid state physics, materials science, biomedicine (radiobiology),
- Synergy with high-energy-density physics and high-energy chemistry

Weaknesses:
- Theory needs supplementation for XUV/x-ray laser-matter interaction and for nano-/microsecond evolution
- Technical staff needs strengthening

Opportunities:
No comments.

Threats:
No comments.

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

H1.1	Quality of selected outputs of Phase I
The quality index of the selected outputs is very good to excellent throughout the entire fields of research covered by the team. A quite significant number of outputs falls in Q1 and Q2.	
H1.2	**Contribution of workers on the outputs reached**
Team members contributed substantially to all outputs evaluated im Phase I.	
H1.3	**Quality of all outputs and results**
The output is very high in total numbers, with a substantial part also being of high quality.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
• Experimental and theoretical probing of Transient Magnetic Fields in laser driven plasma • Materials processing with plasma-based soft-x-ray lasers • Phase transitions induced by XUV/x-ray lasers • Real-time monitoring of thermal and nonthermal melting • Creating and probing dense plasma with XUV/x-ray FEL	

H1.5	Contribution of the participation of the authors in large collaborations
Peak Brightness Collaboration (PBS) on FEL European XFEL PALS	

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 performs mainly fundamental research on high-power laser/matter interaction, with numerous international collaborations. It is intended to gain a better understanding of the basic mechanisms and effects with the goal of future application in materials science and materials processing.	
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**
N/A	
H2.3	**Relation to practice**
Industrial collaborations focused on the development of compact EUV FEL devices and their beamlines: ASML Netherlands B.V., Carl Zeiss SMT GmbH, MESA+ Institute	
H2.4	**Participation in AV21 strategy**
Light at the Service of Society: Presentations to the public via mass media, narrower information channels to scientists. Cooperation with social experts on the history of natural and exact sciences, who are searching and studying the historical roots of developed optical, photonic, plasma and related fields. Mediation activities leading to prospective applications of intense radiation sources and techniques to various partners from related industrial and governmental sectors. Establish and cultivate a synergy between large-scale laser facilities in the Czech Republic and abroad.	
H2.5	**Cooperation with regions of the Czech Republic**
N/A	

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 is very competitive internationally, producing important results.	
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 very active in international cooperation in the main fields:	

- Free-electron lasers (with 4 of the most important international partners: Clarendon Lab, LCLS-SLAC, DESY, European XFEL)
- UV-Vis-NIR lasers and plasma-based XUV/x-ray sources (with 7 international partners: NSF-EUV-ERC (USA), IOE-WA (Poland), IFPiLM (Poland), ENEA (Italy); IMFN (Italy); P.N. Lebedev Physical Institute (Russian Federation), MEPhI (Russian Federation))
- Theory and computer simulations (with 4 international partners: CFEL, Kurchatov Institute, MESA+; DESY; TECHNION)

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

L. Juha served on numerous international and national conferences and committees, J. Krása has been a member of the council of the IPP of the CAS up to present.

L. Juha and J. Krása served on the organization of several conferences and workshops.

Team members presented 19 invited talks, 3 tutorial lectures at international conferences, and obtained 5 prestigious 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 direction of the present research is fully in-line with the perspective of the planned research directions.

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

The research at the PALS facility, the research on laser-matter interactions of long wavelength radiation and of short wavelength radiation and charged particles fully met the research objectives.

The same holds for the work towards UV plasma-chemical lasers and the transfer from large-scale facilities to compact FEL devices.

The previous research objectives were realistic and successfully executed.

D2.3	Assessment of implementation of recommendations from past evaluation

As recommended, the theory group was substantially strengthened.

A strong collaboration with ELI beamlines has been developed; staff members of the PALS center and ELI conducted joint investigations.

Collaboration with the HiLASE team has been started.

D2.4	Success in receiving grants

For the upcoming period, European and national proposals and beamtime application have been applied for resp. already granted.

No detailed information on grants during the present evaluation period was given.

D2.5	Adequacy of instrumental equipment

The instrumental equipment appears adequate.

D2.6	Effectiveness of management

The management appears effective and adequate.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth
The team structure is not fully clear: the administrative and technical personnel (in the “personnel structure“ only one person(?)) seems not to be adequate. Obviously, numerous postdocs have been attracted, also from abroad (they do not appear in the “personnel structure“). The age structure is acceptable. Effort is made to keep the best scientists.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The number of female team members of ~20% appears quite low but is comparable to that of some other teams. Efforts should be made to increase the number of female staff.	
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
Good relations (semestrial lectures, seminars, courses, supervision of BSc and MSc students) with Charles University and Czech Technical University.	
D3.2	**Effectiveness of joint research centres**
Successful collaboration with Charles University and Czech Technical University, both in Prague, and Pavel Jozef Šafárik University in Košice (Slovakia) Further joint research collaborations with numerous universities abroad.	
D3.3	**Success rate in supervision of PhD students**
Team members were successful supervisors resp. consultants for PhD students. 5 Theses were defended (+ 1 in 2020).	
D3.4	**Participation of PhD students in the outputs**
All PhD students participated in the outputs, 4 were first authors.	
D3.5	**Participation of the team in master or bachelor studies**
Team members were supervisors/consultants for BSc and MSc studies.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
See D3.1	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
See H2.4 The laser-plasma chemical experiments motivated by questions around the origins of life on Earth and in the universe (an astrobiology motivation) carried out at the PALS facility are especially suitable for popularization.	
D4.2	**Publishing activities and its quality**
In the Czech Republic, several journals appear (e.g., *Vesmír*, *Československý časopis pro fyziku*, and *Chemické listy*) printing articles in Czech and Slovak languages focused on the wider community of educated and motivated readers – scientists, teachers, technicians/ engineers and students. Staff members of the Department of Radiation and Chemical Physics worked as editors, reviewers and authors of such journals in 2015-2019 (4 articles).	
D4.3	**Participation in professional organisations in the area of research and development**
Československý časopis pro fyziku (founded as *the Journal for Cultivation of Mathematics and Physics* in Prague in 1872) represents the journal of which the scope is closest to our research area. In the years 2008-2017, L. Juha served the community as editor-in-chief of the journal for two five-year terms.	

Other comments of the commission:

The cooperation with the ELI and HiLASE teams should be further strengthened.

The share of work on the evolution of the PALS with the Laser Plasma team of the IPP should be clarified to avoid (independent or competing) double efforts.

20. Development of Lasers and Advanced Technologies (HiLASE)

Strengths:

- HiLase has and provides outstanding instrumentation
- strong national and international connections in science and industry
- team has grown in numbers and became multinational
- service provider for local industy
- high engagement in training and education
- team has now a very good age profile

Weaknesses:

- publication output could be still improved (maybe motivating also users to publish in higher impact journals)
- own scientific outputs outside of laser developments (yet) not very visible
- promotion and marketing tools directed at applications should be further developed

Opportunities:

- ELI connection guarantees a rich field of contacts

Threats:

- focus on service both within ELI and in the HiLASE team may bind a lot of manpower once the laboratories are reaching full operation.
- Limited laboratory space for further developing/construction activities

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

H1.1	Quality of selected outputs of Phase I
The quality index of the selected outputs clearly reflects the fact, that the main part of the team during the last 5 years was contributing to – more technical – laser science and development. Nevertheless the productivity can be accepted as visible on an international level.	
H1.2	**Contribution of workers on the outputs reached**
Compared with the numbers of other teams, the team reaches productivity in the average range, or slightly better. With respect to the technical orientation and the service activities, this has to be seen as an outstanding situation.	
H1.3	**Quality of all outputs and results**
There is a large number of technical papers of excellent quality and also very interesting patents, adding to the productivity on higher indexed publications.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
• The team has a high international visibility for the development of novel diode pumped solid state lasers with high pulse energy and high repetition rate. • Outstanding development of hi-tech industrial applications such as laser shock peening, and laser microprocessing (published in Sc.Reports). • Very good fundamental research of ultrashort laser-matter interactions.	

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 puts high emphasis on training at all levels. In this way, it also serves as an important cooperation partner for local industries.	
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**
High impact by relevant patents and by providing highly specialized service to industries and science. The team may become an important player in the dissemination of laser technologies to external industry partners.	
H2.3	**Relation to practice**
Direct connection to a number of industrial partners	
H2.4	**Participation in AV21 strategy**
Strong participation in the activities “Light at the Service of Society”.	
H2.5	**Cooperation with regions of the Czech Republic**
The team offers a variety of customized lasers (PERLA 100, GO pico/femto) for outside users. The activities also include R&D services, feasibility studies, consultations, laser safety trainings, licensing of patents, and validation of technologies. Finally, it has been able to forge a number of strategic partnerships.	

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 compares favourably with leading teams in other places, e.g. those within German „Fraunhofer Institutes“, sections of the British CLF or similar other institutions.	
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 strongly embedded within the European ELI infrastructures and the Laserlab Europe network. It also has strong and visible collaborations with a number of individual laboratories and universities across Europe.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Organization of various international Summer Schools and provision of educational materials through dedicated website.	

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 planned expansion of the scientific efforts towards • laser-based 2D materials research and applications • lasers in bio-medical applications • advanced laser production technologies • laser safety research • space-borne lasers appear realistic considering the presented achievements. In any case, they are scientifically demanding and very interesting.	
D2.2	**Assessment of the previous research objectives and their achievement**
The team addressed all previous research objectives and very successfully reached the planned goals.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
The team grew since the last evaluation about 30% and seemed to have integrated the new members successfully. In comparison to the previous review the team also strongly improved the training aspects with partners worldwide.	
D2.4	**Success in receiving grants**
The team is impressively successful in achieving grants from funding institutions and industry	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment is of top quality by international standards	
D2.6	**Effectiveness of management**
Given the current team organization, there is actually no visible deficiency in the management structure and strategy.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The management has been able to grow the team over the last 5 years, making it successful. It is not only using the given situation, but also putting effort in training activities and improvement within the team.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The current gender balance is about 65(M)/35(F), which is considered to be good for a laser laboratory. Care must be taken in the upcoming years, though, not to loose this balance again.	
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 cooperation with universities appears to be well established on both a national and international level.	
D3.2	**Effectiveness of joint research centres**
N/A	
D3.3	**Success rate in supervision of PhD students**
The number of PhD student compared to other groups is relatively high and 6 PhD theses have been finished in the time 2015-2019. This can be considered a very good success.	
D3.4	**Participation of PhD students in the outputs**
The PhD students contributed to a large number of manuscripts published in scientific journals with impact factor.	
D3.5	**Participation of the team in master or bachelor studies**
The team has significantly participated in MSc (BSc) studies, enabling 11(10) to be finished in the review period.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several members of the team had a significant number of teaching courses on the BSc and MSc levels, and some fewer on the PhD level, highlighting a functioning cooperation with universities mostly in Prague and Brno.	

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 presented a rich portfolio of outreach activities, popularizing lasers and laser technology and including also activities for children. Particularly noteworthy is the Talent Academy together with the Team 21 concerning ELI and its beamlines.	
D4.2	**Publishing activities and its quality**
The publishing activities of the team are on a very good qualitative level.	
D4.3	**Participation in professional organisations in the area of research and development**
Team members participate actively in several domestic and in international professional organizations including conferences dedicated to research and development.	

Other comments of the commission:
None.

21. Laser Physics at ELI Beamlines

Strengths:

- Team operates 4 highly competitive laser sources and services them for the international community
- Team operates also the world's most intense laser system, e.g. a currently unique facility
- Expert team is truly international
- Demonstrated ability to shoulder large projects

Weaknesses:

- Limited experience in building a strong user community
- Limited knowledge yet to establish a well-defined user program

Opportunities:

- Direct ELI connection guarantees a rich field of contacts
- Opportunity to expand the international collaborations beyond the existing situation

Threats:

- Installation and commissioning of novel scientific instrumentation may bind too many resources, which may then lack in the user support for running experiments

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

H1.1	Quality of selected outputs of Phase I
The quality index of the selected outputs is very good to excellent throughout the entire fields of research covered by the team. A quite significant number of outputs falls in Q1 and Q2.	
H1.2	**Contribution of workers on the outputs reached**
Compared to some other teams, this team certainly excels in productivity. The contribution of the team members to the outputs reaches a good value (34% according the the phase I evaluation).	
H1.3	**Quality of all outputs and results**
The output is very high in total numbers and also in quality. Some patent applications should be noted as well. This is a very good result considering the fact that the number of team members did not change significantly since 2017.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
There are several high-ranking discoveries and findings: • Gamma-ray and e^+-e^- production by enhanced attosecond pulses • Ultra-intense laser-plasma and laser-vacuum interaction • Experimental proof of proton-boron capture therapy (medical application) • Joule-level energy transfer to subpicosecond pulses by a plasma-based amplifier	
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 puts strong emphasis on fundamental science, but also considers societally relevant application activities (medical and energy applications). This approach is fully in line with the CAS and institute's missions. Moreover, the team operates 4 highly competitive laser sources and services them for the international community.	
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 already some cooperations with industry, which can be used to address topics of societal relevance. The team already delivers highly specialized service to science and industry. On the long run, the team may become a strong player in the use and application of high-power laser technology.	
H2.3	**Relation to practice**
Several connections to industrial partners and patents already exist. Given the fact that the group was just built up during the evaluation period, this situation must be considered very favourably.	
H2.4	**Participation in AV21 strategy**
Strong participations in the activities "Light at the Service of Society".	
H2.5	**Cooperation with regions of the Czech Republic**
The team operates a variety of highly specialized lasers for users with access from Czech universities and outside users. With the incorporation of a full user operation, the interest also from Czech partners can still be expected to grow.	

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
Given the unique character of ELI, the team compares very favourably with leading groups in other places and photon-based institutions, such as synchrotron radiation sources.	
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 firmly embedded within the ELI infrastructures. It is also engaged in several H2020 projects, such as EUCALL, ELITRANS, PANOSC and EUPRAXIA. Already more than 40 MoU and cooperation agreements have been signed throughout Europe and the rest of the world.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The team participated strongly in the organization of various international ELI Summer Schools and international conferences. Some members also gave a significant number of invited lectures.	

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 efforts planned are divided into establishing a full user operation of the various laser beamlines, into facility upgrades, and into following a research program addressing • Development of lasers generating high repetition rate ultra-short multi-PW peak power pulses • Particle acceleration by lasers towards a free-electron laser • Radiation-dominated and quantum regimes • Future biology with high-power lasers This direction appears realistic and also very timely, considering the performance of the team and its achievements up to now. The efforts are scientifically demanding and very interesting.	
D2.2	**Assessment of the previous research objectives and their achievement**
The team has addressed all previous research objectives and very successfully reached the planned goals.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
During the evaluation period, the team has considerably increased the efforts in teaching, in parallel to building up the new facility. In this context, a strong involvement concerns the annual ELI Summer School. The training of MSc and PhD students and the teaching at universities has also increased over the years.	
D2.4	**Success in receiving grants**
The team is impressively successful in obtaining grants from European institutions.	
D2.5	**Adequacy of instrumental equipment**
The instrumental equipment is excellent and of top quality by international standards.	
D2.6	**Effectiveness of management**
Given the current team organization, the management has worked very efficiently during the last 5 years.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The management succeeded to establish and grow the team within the last 5 years, making it very successful. This can be seen as a benefit for the ELI operation.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team is relatively new, highly international, and reached the highest number of members (~330 heads) only in 2019. The gender distribution is currently about 75%(M)/25%(F), which should be considered good for a laser laboratory of this size. Care should be taken in the upcoming years, though, not to lose this balance again.	
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.**
The activities and research strategy of ELI Beamlines agrees fully with the requests of the NPS II Programme. It follows a clearly defined research mission and a long-term	

development plan including a strategy of a simple and open access for the scientific community, i. e. will provide its capacity to the national and international community based on free competition. It is and will be used in significant ways to conduct research at a high international level by national and foreign researchers and research teams, executing top science and research projects.

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 team has an impressive network of national and international cooperations with universities and laboratories worldwide.	
D3.2	**Effectiveness of joint research centres**
The team is strongly involved in a number of joined research centres in the Czech Republic, Europe, the US and Japan.	
D3.3	**Success rate in supervision of PhD students**
In the evaluation period 4 PhD theses were defended, which given the temporal evolution of the team's structure can be considered a very good result. Currently there are 21 PhD students working in the team, which has also implemented a procedure to evaluate the progress of PhD students every year.	
D3.4	**Participation of PhD students in the outputs**
The PhD students have been considerably involved in the scientific outputs of the team and are co-authors on the relevant publications.	
D3.5	**Participation of the team in master or bachelor studies**
The team ELI beamlines takes strong efforts in MSc training. During the evaluation period there were 7 MSc theses finished.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Several members of the team have embarked on pedagogical activities, thereby teaching at several universities (Prague, University of South Bohemia) in the Czech Republic, but also in Germany (TU Berlin).	

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

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Three ELI summer Schools were organized in Prague, in addition to elementary and secondary school visits and open days for the general public.	
D4.2	**Publishing activities and its quality**
23 (semi)popular publications of very high quality (Nature, Physics World, SPIE, Laser Focus World, Czech TV ...)	

D4.3	Participation in professional organisations in the area of research and development
Strong involvement of team members in international Coordination/Steering-Boards/Committees, Editorial Boards, Advisory Boards (total of 24).	

Other comments of the commission:
It is not clear what is the actual contribution of the Prague ELI team in relation to the ELI teams in Romania and in Hungary. Maybe this needs to be more clearly stated?

Final report was elaborated by:

Commission 2 - Physical sciences
Evaluated teams No.: 1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20, 21

Commission Chair: Prof. Martin Stutzmann
Commission Deputy Chair: Karol Flachbart
Commission Members:
- Wojtek Bock
- Ingo Dierking
- Niall English
- Stefano Forte
- Peter Grabmayr
- Sebastian Hoenig
- Thomas Kuehl
- Massimo Persic
- Juergen Reif
- Jochen Schieck
- Claus Schneider

Commission 7.1 - Engineering and technology
Evaluated teams No.: 4, 6, 16, 17, 18

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