

Analysis of Science and Research Management at TUL between 2014 and 2020

1 ORGANISATION, MANAGEMENT AND SUPPORT FOR R&D&I

1.1 Organisation and management of R&D&I

In the R&D&I management process, the role of TUL Rector's office lies in defining the mission, vision, and strategy for longer periods of time in order to preserve and develop existing core R&D themes, while giving room for the development of the new themes. The key task of TUL Rector's office in the R&D management process is setting rules, implementing internal processes and cultivating the environment. The departments of the Rector's office provide methodological and administrative support to major projects from European funds through the Operational Programmes Department and methodological and administrative support in the area of knowledge transfer and the provision of motivational and supportive R&D tools used by the respective organisational units of the university through the Science and Research Department.

The key strategic advisory body of TUL rectorate is the Scientific Council of TUL, which provides feedback on the strategic and process settings of R&D management at TUL. In the event of an international overlap of scientific themes researched and studied at TUL, feedback is provided by the International Scientific Council of TUL. All key procedural settings and the division of institutional support among respective organisational units are subject to approval by the Academic Senate of TUL, which guarantees the high stability and permanency of the R&D management system at the university.

Organisationally, TUL consists of eight respective organisational units (seven faculties and one institute) headed by a Dean or Director. They fulfil the university's mission, vision and strategy in their fields up to a detailed interpretation at the level of departments. The key advisory and control body for the management of TUL organisational units is the Scientific Council of the individual faculties. Control of procedural settings and financial management at the faculties is carried out by their academic senates. Given that the activities of TUL cover a wide range of disciplines, it is not possible to use a unified model for effective R&D&I management. Depending on

the characteristics of the major fields of interest, there are several R&D&I management models implemented among the TUL organisational units:

1) The Dean's/Director's office provides complete project support (financial management and methodological support) most often implemented by a narrow administrative team. Departments are usually not divided into lower organisational units (research teams). Project teams are created according to the needs of current projects (e.g. TACR, GACR) across departments and are not institutionalised in any way. This type of R&D management is characterised by great flexibility of employees, who participate in the interdisciplinary tasks across all the faculties, and has a highly innovative potential. (FSHP, FAA, FHS, EF, FMIIS, FTE).

2) the Dean's office again provides complete project support, but the departments are independent units guaranteeing R&D activities and education in the respective R&D areas. There are research teams in the department that can be interdisciplinary and, therefore, interdepartmental or interfacultural. The activities of the research teams are defined by the research programme. The Vice-Dean for Scientific Research and Cooperation with Industry and the Vice-Dean for Doctoral Studies and Development are authorised to provide methodological support. This type of R&D&I management is based on the stability of the field built on a long tradition of strong links to industry, which presuppose a basis of balanced staffing and good technical equipment. (FME)

3) The core research organisational units of the Institute are research departments (8) and laboratories (2) with defined research objectives, long-term visions and strategies to achieve them. The Director's office provides technical and administrative tools through several separate support departments that provide research units with support for grant management, promotion, human resource development and industrial relations development. This type of centralised management has a high potential of achieving the defined goals and maintains a high standard of performance, thereby enabling it to keep pace with the requirements of the industrial partners collaborating on contractual research or with whom the Institute collaborates through themes of joint projects. (Cxl)

Table 1.1.1 Structure of staff contributing to the university's R&D&I (numbers of physical employees and workers)

Academic/professional position/year	Total						Of whom women					
	2014	2015	2016	2017	2018	total	2014	2015	2016	2017	2018	total
Professors	68	67	68	65	59	327	2	2	2	2	2	10
Associate professors	106	112	107	109	113	547	21	24	25	27	30	127
Assistant professors	470	406	391	390	411	2068	214	176	178	167	181	916
Assistants	25	24	26	24	20	119	11	9	13	9	10	52
Scientific, research and development staff contributing to teaching	0	5	6	3	0	14	0	2	2	1	0	5
Postdoctoral fellows	110	97	81	74	83	445	44	43	42	33	28	190
Ph.D. students	10	7	11	10	10	48	7	3	4	3	4	21
Other scientific, research and development staff	108	81	83	86	107	465	31	28	31	36	39	165
Scientific staff outside the above categories	0	0	0	0	1	1	0	0	0	0	1	1
Total	777	695	681	677	711		279	241	251	242	263	

Note: This is the total number of employees/workers as of 31 December of the calendar year in question (in full-time or part-time employment, excluding persons with contracts for services or contracts for work). They do not include other contractual arrangements under the Civil Code concerning the purchasing of services.

Note: "Postdoctoral fellows" are staff at the research institution or university up to five years after defending their Ph.D. qualifications or equivalent. They work as part of the institution's research team, usually under the guidance of experienced scientific staff on specific tasks, and they publish their results both individually and as part of their teams. They have fixed-term employment contracts with the research institution (for 1–3 years) for between one and a maximum of three successive terms of employment. Their salaries are subject to the rules for the institution's salary system, and they may additionally receive remuneration as part of their research grant projects.

"Ph.D. students" is the number of doctoral students regardless of whether they are employed or not.

"Other scientific, research and development staff" covers technical and professional staff who are not directly involved in R&D&I, but are indispensable for research work (e.g. servicing the research facility).

"Scientific staff outside the above categories" covers all other staff who cannot be classified under any of the categories listed (e.g. independent scientific/research workers).

Table 1.1.2 Structure of staff contributing to the university's R&D&I (average converted numbers)

Academic/professional position/year	Total						Of whom women					
	2014	2015	2016	2017	2018	total	2014	2015	2016	2017	2018	total
Professors	52.18	48.5	52.87	50.2	46.1	249.85	2	2	2	2	2	10
Associate professors	93.43	89.98	93.74	95.8	99.1	472.05	17.84	20.92	22.57	24.7	27.8	113.83
Assistant professors	358.9	357.0	358.8	356.7	358.2	1789.7	181.6	155.	160.1	157.4	157.2	811.57
Assistants	21.24	22.36	21.63	17.2	15.3	97.73	9	9.7	10.67	7	5.3	41.67
Scientific, research and development staff contributing to teaching	0	3.8	4.43	1.8	0.4	10.43	0	0	1.1	0.1	0.1	1.3
Postdoctoral fellows	99.07	88.59	74.39	66.52	70.83	399.4	37.12	37.3	35	27.55	23.9	160.87
Ph.D. students	3.95	3.8	5.7	5.8	5.46	24.71	3.6	1.5	2	2.3	2.86	12.26
Other scientific, research and development staff	16.76	9.57	55.99	55.3	54.2	191.82	7.53	3.8	22.93	22.8	21.1	78.16
Scientific staff outside the above categories	0	0	0	0	1	1	0	0	0	0	1	1
Total	542.5	531.2	587.5	577	574.3		218.0	191.7	219.4	214	214.5	

Note: The average converted number is the proportion of the total number of hours worked over the monitoring period from 1 January to 31 December by all workers (excluding persons with contracts for services or contracts for work) and the total annual working hours of a full-time employee.

1.2 Support system of R&D&I and measures to stimulate high-quality science

At TUL, several systemic stimulation measures are in place to support the quality of R&D&I.

Grant programmes of the Technical University of Liberec (hereinafter referred to as GP TUL) were established, in which the principles of using part of the institutional support for long-term conceptual development of the research organisation (LCDRO). The main aim of GP TUL is to strengthen the quality of scientific work at TUL, increase the prestige of scientific teams at an international level, increase the success in submitting prestigious national and international grants and short-term funding for the creation of results with high added value. The support of basic research within the GP TUL is implemented through defined university-wide grant competitions for scientific teams and individuals at TUL producing results that will succeed at an international level. The main selection criteria in all types of support are

- (i) the research excellence of the principal investigator,
- (ii) the quality of the submitted proposal, which should be competitive at the international level, and
- (iii) the excellency of the delivered results of basic research.

There are currently three grant programmes underway:

1) The PURE grant programme (GP PURE) has been introduced in order to support basic research. Its strategic objectives are:

- (i) long-term enhancement of the performance and quality of scientific work in the field of basic research at TUL,
- (ii) increasing the prestige of TUL research teams
- (iii) supporting the creation of excellent, internationally competitive results; and
- (iv) increasing the success of TUL teams in grant competitions of national (GACR) and international (ERC) research grant providers.

The tool of implementation is targeted support of talented and motivated scientists, who, together with their teams, work on specific, clearly defined and original projects with the potential to influence the field and to make a significant impact on the international level. The grant program is announced for the period from 1 July 2019 to 31 December 2025 with total allocated funds of at least 15 million CZK and optimally 30 million CZK. Pilot projects in the first call were launched on 1 June 2019.

2) The RISING-STARS grant programme (hereinafter referred to as GP RISING-STARS) has been introduced in order to support basic research of young academics and researchers. GP RISING-STARS follows strategic goals and uses the same tools as GP PURE. However, GP RISING-STARS is a stand-alone grant programme in which only TUL junior staff members, who were awarded the title of PhD or equivalent seven years ago at the latest can apply for support. GP RISING-STARS was announced for the period from 1 July 2019 to 31 December 2025 with total allocated funds of at least 10 million

CZK and optimally 20 million CZK. Pilot projects in the first call were launched on 1 June 2019.

3) The ENAGO grant programme (hereinafter referred to as GP ENAGO), whose strategic objective is to (i) improve the quality of publication results of doctoral students, academics and researchers at TUL, (ii) to promote quality and the scientific impact of articles' main ideas, and (iii) to strengthen the potential contribution of published articles to TUL in terms of M17+ methodology evaluation.

The Student Grant Competition (hereinafter referred to as SGC) is an important tool that can positively contribute to the cultivation of the research environment at TUL. SGC also represents a key tool of TUL and its components for managing the quality of R&D results of doctoral students. Furthermore, it is one of the few tools to reach students of Master's degree programmes and involve them in scientific activities at the university faculties/institute and thus motivate them for future doctoral studies. At TUL, SGC is managed at three levels - university, faculty and workplace. Since 2018, there has been a gradual tightening of the quality requirements for student projects and a gradual improvement in the quality of SGC quality control and quality control processes.

TUL uses internationalisation support tools to increase the involvement of TUL teams in international collaboration. The key projects are OP RD&E projects (CZ.02.2.69/0.0/0.0/16_027/0008493), international mobility of researchers at TUL (MOTUL) and further prepared MOTUL II. These projects provide TUL organisational units with significant financial means for the mobility of our employees to prestigious foreign workplaces and also to facilitate the mobility to TUL of important employees from abroad. Other tools are mainly support for participation in international conferences, support for international internships of students, academics and researchers, organisation of international conferences at TUL, and others.

TUL organisational units are now undergoing deep revisions of strategic plans in R&D, which are related firstly to the call of the Ministry of Education to prepare a new strategic plan for the period after 2021, and secondly to planned changes in the institutional support on the LCDRO. The organisational units are currently making

changes to the systems for allocating and drawing subsidies to LCDRO, which are based on strategic planning and the quality of R&D results. This process will naturally result in gradual revisions of career rules on the faculties/institute, where it is already in place, and their gradual implementation in other TUL organisational units.

1.3 Institutional regulations for the use of institutional support for the LCDRO

The split of the institutional support among TUL organisational units is a subject to approval by the TUL Senate. In the period 2014-2018, its further split was fully in the competence of individual faculty/institute management, taking into account the following criteria:

- 1) Split of LCDRO funds into individual departments based on their recognised results and outputs for the given calendar year.
- 2) Supporting the creation and opening of new R&D themes with the aim of creating a knowledge base for submitting basic and applied research projects to the calls of national and international providers.
- 3) Renewal and development of technical equipment
- 4) Support of stable scientific teams temporarily without grants.

Supported research specialisation usually arises in relation to respective study programmes. The approach of faculties differs according to their specialisations and strategies (supporting the development of a potentially successful fields or new R&D topics or, on the other hand, utilisation of high-quality facilities with a demand for excellent outputs in the areas of evolving research trends, co-financing of R&D projects with own (public) funds or funding of promising research themes temporarily without a grant.

Since 2019, the stabilising component of LCDRO funds continues to be split among TUL organisational units as described above. Based on the Decision of the Rector and consensus across TUL, the LCDRO funds consist of general stimulation component that is directed to grant programs (PURE, ENAGO, RISING-STARS) and partly redistributed to

individual TUL respective organisational units according to the results in modules 1 and 2 of Methodology 17+.

The use of LCDRO funds by research teams at the workplaces of TUL faculties/institute is subject to internal rules based on the R&D strategy of the respective organisational unit. Within these internal rules, creative activities (number of projects solved, publications, eventually exhibition activities) are monitored and these funds are further allocated based on the collected data. At FME, the allocation of LCDRO funding on individual workplaces is performed on the basis of the Directive of the Dean for Determining Workplaces Performance.

Since 2020, the performed strategy of some organisational units has been to encourage the participation of researchers in GP PURE and GP RISING-STARS by contributing from the LCDRO faculty/institution budget. Some organisational units also supported LCDRO's GP PURE and GP RISING-STARS projects, which were recommended for funding by the expert evaluators, but which were not funded due to limited budget of the general stimulation component of the LCDRO fund.

1.4 Strategy for the establishing, financing and long-term development and sustainability of research centres and large research infrastructures

TUL has established the Centre for Nanomaterials and Advanced Technologies (Cxl). It is a university institute established within the extensive Research and Development for Innovations (R&DforI) project. The Cxl Sustainability Strategy is based on maintaining a broad portfolio of financial resources, consisting of national research projects (TACR, MIT, MI, etc.), international projects (H2020, Eureka, Life, etc.) and collaborative and contractual research contracts. Cxl also draws institutional support for LCDRO allocated according to the same rules as the other TUL organisational units. Since Cxl consistently meets the requirements given by the Framework for State Aid for Research, Development and Innovation (EC 2014/C198/01) thanks to the revenues it obtains from collaborative and contractual research, it can be stated that Cxl is a sustainable organisational unit with annual turnover of 300 million CZK (2019).

1.5 Training system in the area of intellectual property protection and technology transfer

The system of protection of intellectual property (IP) and knowledge transfer (KT) is generally a very complicated matter at universities. The university system must effectively address the dilemma: on the one hand the effort to quickly disseminate scientific results, and results of basic research in particular, among the general professional and general public, and at the same time the efforts to protect and capitalise on the resulting know-how through the KT process. Since each case of commercialisation of IP is usually quite unique, it is unthinkable to create a unified procedure of KT, e.g. in the form of an algorithm that would be universally applicable. The experience of key employees in the management of TUL and its organisational units plays an essential role in the KT process at TUL.

The IP protection system at TUL is currently governed by the Directive of the Rector on the Protection of Intellectual Property, which lays down basic rules for the flow of information about the IP and the basic duties of key persons in the process of KT. The Commercialisation Council, which is the Rector's advisory body, plays the principal role in the KT process. The system is under the umbrella of the Technology Transfer Support Centre, which provides on the level of rectorate management, besides consulting services, legal services and interpretation of internal standards regulating this issue.

It is clear from the aforementioned facts that the issue of education in the areas of IP and KT protection is very important at TUL, especially for the application focus of many of its organisational units. At present, TUL is performing the OP RD&E university level project entitled "Effective Technology Transfer Process at the Technical University of Liberec" Reg. No. CZ.02.2.69/0.0/0.0/16_014/0000631 (Implementation period: 01/02/2017 – 31/01/2021) with a budget of 32 million CZK (<http://cptt.tul.cz/projekt>). The aim of the project is to create a personnel and information basis for TC and education of academic staff in the given field. The project outputs will be incorporated into a comprehensive KT system, together with further update and optimisation of internal regulations and related processes at TUL. The main output of the project will be a system of competent persons - Technological Scouts, which will operate across

TUL organisational units. These technological scouts will provide methodological support to academic staff who will have the subjects of commercialisation in the process of IP protection and in the process of finding the appropriate form and legal procedure of the KT to industry application. The project will equip technological scouts not only with the necessary knowledge, but also with written and SW tools and aids that will be included in the KT system at TUL. Furthermore, a structure of trained workers at key TUL workplaces will be defined. At this stage, TUL is not expected to create a specialised workplace that would deal with KT independently, but in the future the project outputs would not exclude the establishment of such a workplace.

An equally important activity at TUL is work with undergraduates and graduate students. EF founded the Student Business Club (SBC) in 2015. SBC supports entrepreneurship and student innovation projects through competitions: The Student Innovation Project, Locally and Time unique Start-up, Technology Start-up or Spin-off. In 2015, 17 teams participated in the competition, six teams advanced to the finals. In 2016: 26 teams, seven in the finals. In 2017: 26 teams, seven in the finals. In 2018: 21 teams, seven in the finals. Every year, the SBC organises a Summer School of Business (Business Workout), which is intended for students at all levels of study and graduates of all TUL faculties.

2 DOCTORAL STUDIES

2.1 Organisation of doctoral studies

Doctoral studies are carried out at organisational units of TUL in doctoral study programmes (DSP) whose organisation, content, form and staffing have been accredited by the National Accreditation Office (formerly the National Accreditation Commission). Doctoral studies are organised in accordance with the Higher Education Act No. 111/1998 Coll., The TUL Study and Scholarship Regulations and, if issued, with the Directives of the Dean on the organisation of doctoral study programmes at TUL organisational units. The standard length of doctoral studies at TUL is four years. The form of study can be both full-time and combined.

Organisation of doctoral studies: The Advisory Board (AB) plays a key role in the quality management of the doctoral study programme (DSP). In particular, it evaluates individual study plans (ISPs) of doctoral students, comments on the activities of supervisors, checks the fulfilment of ISPs and other study duties of doctoral students, and comments on changes to the ISPs. The AB proposes to the Dean the rolls of committees for the State Doctoral Examinations and the defence of doctoral theses and, therefore, represents a key tool for detecting potential conflicts of interests of individual members appointed to the committees. The AB proposes to the Dean to stop the doctoral study of students who do not fulfil the required points of their ISP. It comments on conceptual changes to a particular DSP. The Vice-Dean responsible for doctoral studies coordinates the activities of individual ABs at the faculty, prepares documents for the ABs, organises entrance examinations, state doctoral examinations and defence of theses, and promotes doctoral studies at meetings with students. The DSP guarantor conceptually develops the study programme, prepares documents for accreditation and is also the Chairperson of the AB.

Progress and control of study: DSP studies are carried out according to the ISP. In some TUL organisational units, the ISP may be updated by annual study plans (ASPs) under the guidance of a supervisor based on activities from the previous period and direction of study. The supervisor is a key partner, guide and mentor to his/her student. The supervisor, in cooperation with the doctoral student, prepares the ISP and the ASP and leads the student professionally and organisationally during his/her studies. The supervisor continuously monitors the fulfilment of the study obligations and submits an annual study evaluation to the AB. The fulfilment of the ISP of the doctoral student is subject to regular, at latest annual, evaluation of the AB.

Study requirements: The ISP includes at least three examinations in professional subjects and an examination in English. The number of examinations may be higher. The student is obliged to take examinations within two years of enrolment. Language training is completed by an English language examination or is certified by a language proficiency certificate. Fulfilment and completion of study obligations are

demonstrated by the doctoral student by passing examinations before the examination board.

In some organisational units of TUL, the doctoral student's duties in the first year of study include the elaboration of research, professional study, from the existing knowledge and current state of knowledge in the field of doctoral theses. The student defends the completed research in the colloquium. The research must contain a brief summary of the state of the art of the studied issue in the world (literature and patent research), supplemented by the summary of the achieved results of the work to date in the field of the theme of the thesis. At other TUL organisational units, this research is replaced by elaborating a Draft Thesis in the second year of the study. This draft is defended at the State Doctoral Examination.

Teaching activities: The DSP student's duties also include teaching activities. In some TUL organisational units, the description of the pedagogical activities of the doctoral student is a part of the ISP. The student usually participates in teaching activities by leading seminars in technical subjects, leading students' projects, leading seminars, leading lectures and consulting final theses.

Research activity: The doctoral student must actively participate in the scientific activities of the workplace, especially being part of teams of projects funded by national or international providers. He/she must publish the results of his/her thesis, as publication results are a necessary condition for applying for the defence of the thesis. The specific requirements for the quantity and quality of the doctoral student's publication results are set by the AB or by the Dean's guidelines. Other activities of the doctoral student include active participation in doctoral and international conferences.

Internship: At most organisational units of TUL, the doctoral student's duties include at least one internship abroad at a university or research facility with a similar focus for at least three months. Upon returning, a seminar informing about the results and conclusions of the internship is organised at the student's workplace. In justified cases and after approval by the AB, the internship abroad can be replaced by participation in an international research project or by other form of direct student participation in an

international collaboration. Internships abroad should be completed during the second or third year of study.

Other obligations: In some organisational units of TUL, the student's duties include attending at least two seminars to acquire additional competencies and personal growth of the student, so-called soft skills.

State Doctoral Examination (SDE): After successful completion of the examinations and a sufficiently elaborated draft of the thesis, the student enrolls in the SDE. The SDE consists of an oral examination concerning professional issues from the previous period of study and also a professional discussion on the draft of the thesis, in which the student informs about the achieved goals so far and the state of work in progress. The SDE takes place in the presence of the examination board. The course and requirements in terms of the SDE are specified in the Study and Examination Regulations of the Technical University of Liberec (SER).

Dissertation: After successfully passing the SDE and submitting the dissertation, the student also submits an application for a dissertation defence. A prerequisite for the defence of the dissertation is the fulfilment of all necessary conditions defined in the student's ISP and other faculty directives. The content of the dissertation is given in the SER. The Thesis Defence Committee is appointed by the Dean upon the proposal of the AB. Expert evaluators of the thesis can only be distinguished experts in field at an international level. The defence of the thesis proceeds according to SER of the TUL.

Promotion and Recruitment: The promotion and recruitment of DSP students is carried out annually on a targeted basis through the website of each TUL organisational unit, which lists the topics of the thesis with the name of the supervisor in Czech and English.

Communication: In terms of external communication, the individual TUL organisational units cooperate on themes and other activities in the execution of the DSP not only with the Czech Academy of Sciences, but also with the application and industrial spheres, and also organise recruitment abroad.

In 2017, an Agreement on Collaboration in the Implementation of Doctoral Degree Programmes was signed between the CAS and TUL. At present, the most intensive collaboration is with the Institute of Plasma Physics of the CAS, the Institute of Physics of the CAS, the Institute of Information Theory and Automation of the CAS, the Institute of Thermomechanics of the CAS, and others.

Based on our relationships with industry partners, we annually announce themes related to the application sector. Last but not least, we offer thesis themes on the TUL website and also send to partner universities abroad.

Basic statistical data on doctoral study programmes is presented in Table 2.1.1

Table 2.1.1: Basic statistical data on doctoral study programmes: the number of active doctoral students, doctoral graduates and the number of DSPs in TUL organisational units.

2014	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	Number of active doctoral students	42	93	12	131	89	0	0	0
	Number of doctoral graduates	8	14	1	23	5	0	0	0
	Number of DSPs	8	6	4	12	4	0	0	0
2015	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	Number of active doctoral students	35	82	11	128	97	10	0	0
	Number of doctoral graduates	9	11	0	8	4	0	0	0
	Number of DSPs	8	6	4	12	4	2	0	0
2016	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	Number of active doctoral students	30	77	11	99	87	11	0	3
	Number of doctoral graduates	3	7	0	15	10	0	0	0
	Number of DSPs	10	6	4	12	4	2	0	2
2017	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	Number of active doctoral students	25	67	11	85	71	15	0	17
	Number of doctoral graduates	6	8	1	13	13	0	0	0
	Number of DSPs	8	6	4	12	4	2	0	2
2018	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	Number of active doctoral students	19	56	11	80	67	16	0	23
	Number of doctoral graduates	7	10	1	12	4	0	0	0
	Number of DSPs	12	6	4	24	6	2	0	2

* Faculty of Economics (EF), Faculty of Mechatronics, Informatics and Interdisciplinary Studies (FM), Faculty of Science, Humanities and Education (FP), Faculty of Mechanical Engineering (FS), Faculty of Textile (FT), Faculty of Arts and Architecture (FUA), Faculty of Health Studies (FZS)

2.2 Internationalisation of doctoral studies

The internationalisation of doctoral studies is an important tool for TUL to improve the quality of scientific work, especially of young researchers. Most TUL organisational units (EF, FM, FS, FT) have accredited DSPs in English. Most foreign DSP students are actively involved in Student Grant Competition projects. At the same time, a standard element of DSP accredited at TUL in Czech is a compulsory three-month internship at a partner workplace abroad.

The Faculty of Economics has signed a bilateral agreement with the University of Sankt Gallen, Switzerland (the world's leading university in economic fields), which allows two doctoral students to complete a semester stay in Sankt Gallen. In 2014-2017 prof. Norbert Reetz of the University of Sankt Gallen delivered an advanced microeconomics

course for doctoral students of EF TUL in Liberec. In addition, doctoral students of EF TUL benefit from the possibility of semester internships at the Technical University of Dresden, Germany, which is one of the so-called excellent universities in Germany. In 2019, collaboration was established with the Norwegian University of Science and Technology (NTNU), Norway, and within the framework of the Erasmus + programme a seminar focused on qualitative research methods for doctoral students of EF TUL was held. In the same year, collaboration with NTNU was extended to the field of technical sciences (Engineering) with planned collaboration, especially with doctoral students from FM and FS.

The Faculty of Textile Engineering is a well-internationalised part of TUL, where the number of foreign doctoral students is higher than the number of doctoral students with Czech citizenship, which is the result of excellent international activities of FT TUL academic staff. FT proves that hosting academic staff from foreign institutions and developing international R&D contacts is the most effective way of recruiting high quality students into DSP accredited in English. FT's most important foreign partners include the Indian Institute of Technology, Delhi, India; Kyoto Institute of Technology, Japan; Shinshu University, Nagano, Japan; etc.

The Faculty of Mechanical Engineering is very active in offering doctoral studies to foreign students and currently the share of foreign doctoral students is 18%. The most important foreign partners of the FS include Lodz University of Technology, Lodz, Poland; King Mongkut University of Technology North Bangkok, Thailand; The University of Stuttgart, Germany, etc.

The Faculty of Mechatronics is involved in a wide network of foreign universities with which collaboration is contractually regulated through the MOU. Exchange stays take place within the framework of Erasmus+, credit mobility KA107, and further support through mobility funds (IP project). Individual contacts of doctoral student supervisors play a very important role in creating international collaboration. The faculty provides support to trainees (it ensures accommodation booking, visa processing, etc.). FM successfully implements the double supervision of the doctoral study "en cotutelle". Currently there are two graduates of the "en cotutelle" DSP, which was granted

together with l'Université Toulouse 3 Paul Sabatier, Toulouse, France. At the FM, a joint-degree DSP "Environmental Engineering" with the University of Opole, Poland is currently prepared.

TUL is continuously working on improving the internal environment for foreign students. We are preparing handbooks for doctoral students studying in English "Guidebook for new doctoral students at TUL". The Study Officers on the TUL organisational units in collaboration with the International Department of TUL and the Erasmus Student Network (ESN) Student Club provide targeted support to incoming students, including accommodation, provision of arrival support, eventual transport assistance to the campus / dormitory participation in Orientation Week, providing support to students in administrative processes during enrolment for studies, and solving problems arising during their studies. We provide incoming students with information about the possibility of joining the ESN Club and about opportunities to participate in joint events of foreign and domestic students, etc. For foreign students in DSP, a system of financial evaluation has been developed at the FS. It is a form of Merit Scholarship (financial contribution to study in fulfilling study obligations), or publication scholarship for significant publication outputs, etc.

Although the management of TUL and its organisational units did not formally institutionalise the "Doctoral School," TUL and its organisational units naturally provide courses that are common for these doctoral schools. These include courses in soft-skills such as Academic Writing, Patent Search, Protecting Inventions and others.

2.3 Subsequent careers for doctoral graduates

The management of TUL and its organisational units consider the support of international mobility of doctoral students during their studies as the most important system measures for the support of doctoral graduates. These include in particular compulsory internships, internships, summer schools, conferences and teaching stays. Mobility is supported under the Erasmus+ University mobility programme, Erasmus+ KA107 faculty projects for mobility outside the European Union, CEEPUS, the Faculty Mobility Funds, formerly the TUL Mobility Fund. In 2013-2015, the TUL organisational units were involved in the OPEC project entitled "Support for Creation of Excellent

Research and Development Teams at the Technical University of Liberec". Since 2018, the OP RD&E project entitled "International Mobility of Researchers at TUL" has become an important tool for support of mobility. The employment of doctoral graduates is further supported mainly through personal contacts of supervisors to prestigious workplaces abroad.

Table 2.3.1 lists the positions of DSP graduates at TUL. Our graduates have earned interesting researcher positions at European universities, and prestigious senior positions at Asian universities.

During the reporting period, approximately 30% of doctoral graduates continue to work at TUL and approximately 70% continue their professional life outside TUL.

Table 2.3.1 Information on subsequent careers for doctoral graduates

Graduate's name, surname (initials) and degrees	Discipline in which the graduate obtained a Ph.D. in the Czech Republic	Year in which a Ph.D. was obtained	Subsequent career
			Employer, position, employment period
Ing. Martin Sturm, Ph.D.	Machines and Equipment Design	2018	Vertretungsprofessur Fertigungstechnik, Fertigungsmesstechnik und Qualitätsmanagement Hochschule Zittau/Görlitz Fakultät Maschinenwesen
Ing. Ondřej Kotera, Ph.D.	Engineering Technology	2012	Research Assistant Fraunhofer-Institut für Werkzeugmaschinen und Umformtechnik IW
Nguen Van Tuong, Ph.D.	Machine and Equipment Design	2009	Děkan, Faculty of Mechanical Engineering Nha Trang University, Vietnam
Tran Doan Hung, Ph.D.	Materials Engineering	2011	Vice rector Nha Trang University, Vietnam
Ing. Renata Čuhlová, Ph.D., BA (Hons)	Business management and economics	2017	Zhejiang Financial College, Czech Research Centre, Hangzhou, Čína - Researcher in International Trade, 2018-dosud
Guocheng Zhu, M.Eng., Ph.D.	Textile engineering	2015	Distinguished professor, Department of Textile Engineering, College of Materials and Textiles, Zhejiang Sci-Tech University, Hangzhou, P.R.China
Juan Huang, M.Tech., Ph.D.	Textile engineering	2016	Department of Nonwoven Science and Engineering, School of Textile Science and Engineering, Wuhan Textile University, Wuhan, Hubei Province, P.R. China
Yan Wang, M.Eng., Ph.D.	Textile engineering	2017	Stokes Laboratories, Bernal Institute, University of Limerick, Limerick, Republic of Ireland
Nongnut Sasithorn, M.Sc., Ph.D.	Textile engineering	2016	Department of Textile Chemistry Technology, Faculty of Industrial Textiles and Fashion Design; Rajamangala University of Technology Phra Nakhon, RMUTP, Bangkok, Thailand

2.4 Rules for funding doctoral students, including foreign students

The funding of doctoral students at TUL is different based on whether they are students studying in the Czech language or students studying in the English language. Students studying in the Czech language are financed from the state budget and other resources usually in the form of scholarships. Students studying in the English language pay for their studies. These tuition fees are set by the Rector's directive - tuition fees and by ordinances of the deans of individual faculties. Doctoral students may also receive additional scholarships under certain conditions. The conditions for granting scholarships are determined by the TUL Scholarship Regulations and by the directives of the deans of individual faculties.

There are currently four basic sources of funding at TUL: (i) a state grant for scholarships for students in the doctoral study programme (DSP), (ii) an institutional subsidy for LCDRO; (iii) specific grant for Specific University Research (SUR) (iv) other public and private resources, which include in particular block grants for basic and applied research projects (GACR, TACR, MIT, etc.), university and national development programmes (IP, OP, etc.) and collaborative and contractual research projects. A breakdown of these resources by year and by TUL organisational units is shown in Table 2.4.1.

Table 2.4.1: Data on the structure of resources for funding of doctoral study programmes.

2014	Organisational unit	EF	FM	FP	FS	FT	FUA	FZS	REK
	State contribution to scholarship to students of DSP								
	Personnel costs and scholarships paid out of the institutional support for LCDRO.								
	Personnel costs and scholarships paid out of the SUR								
	Personnel costs and scholarships paid out of the block grants								
	Personnel costs and scholarships paid out of other resources								
	TOTAL								
	Number of active students								
	TOTAL FOR ACTIVE STUDENTS								

* Faculty of Economics (EF), Faculty of Mechatronics, Informatics and Interdisciplinary Studies (FM), Faculty of Science, Humanities and Education (FP), Faculty of Mechanical Engineering (FS), Faculty of Textile (FT), Faculty of Arts and Architecture (FUA), Faculty of Health Studies (FZS)

The incentive and motivational tools applied to the distribution of scholarships among individual doctoral students in Czech DSPs are defined in the directives of the deans of the individual faculties. These directives usually define the following components/scholarship contributions:

- i) basic scholarship,
- ii) scholarship for academic publications
- iii) scholarship for academic internship/study abroad
- iv) scholarship for outstanding results in studies and professional activities,
- v) scholarship for self-paying students studying in a foreign language for fulfilling their study commitments,
- vi) scholarships paid on the basis of a student’s participation, activity and achievements in a project supported by the TUL Student Grant Competition.

Beyond the framework of scholarship, doctoral students are supported from other public and non-public sources and their long-term internships. Foreign students are supported in the case of medical examinations.

Most of the best doctoral students are involved in basic and applied research projects, with a corresponding employment contract.

In the case of excellent study and research results, doctoral students in a DSP accredited in English may ask the Dean to reduce the tuition fee to a symbolic value (they use this option). In addition, they may receive an exceptional scholarship for research work up to the same level as full-time students in a DSP in Czech.

3 NATIONAL AND INTERNATIONAL COOPERATION AND MOBILITY IN R&D&I

3.1 Significant cooperation in R&D&I at national level

In the area of basic research, TUL cooperates with a number of universities and institutes of the Academy of Sciences of the Czech Republic. In the field of applied research, TUL is involved in cooperation with several important clusters. Below are the most important examples of R&D&I cooperation at a national level.

1) Institutes of the Academy of Sciences of the Czech Republic: In the area of basic research, the most important cooperation is with the Institute of Plasma Physics, in particular with its Regional Centre for Special Optics and Optoelectronic Systems (TOPTEC). Several projects of GACR and TACR have also been performed in the framework of this cooperation and TOPTEC employees are intensively involved in lecturing in Bachelor's and the following Master's degree programmes, and the further education of doctoral students.

TUL has a long-term and significant cooperation with the Institute of Thermomechanics and the Institute of Physics. Other projects were performed with the Institute of Physiology, Institute of Geonics, Masaryk Institute and Archives of the CAS, Institute of Scientific Instruments, Institute of Inorganic Chemistry, J. Heyrovsky Institute of Physical Chemistry, Institute of Atmospheric Physics, Institute of Materials Physics, Institute of Organic Chemistry and Biochemistry, and Institute of Information Theory and Automation.

In addition to joint grants, the breadth and intensity of cooperation with the institutes of the Academy of Sciences of the Czech Republic can be demonstrated by joint publications and the joint organisation of conferences. Between 2014 and 2018, 14 basic research projects, seven applied research projects and four research

infrastructure projects were performed with the institutes of the ASCR. The total volume of joint funds amounted to 930 million CZK over the entire project period.

2) Nanoprogress: Through CxI, TUL holds collaborative research contracts from the Nanoprogress cluster. In 2016, the cluster was awarded the title of Golden Cluster 2016 for the most dynamic cluster of the year 2016. In the evaluation of cluster organisations, conducted by FaME and NCA in 2012 and 2016, Nanoprogress moved from 27th to 3rd place in the performance ranking. In addition, the cluster was awarded the Cluster Management Excellence Gold Medal. With this award, Nanoprogress is ranked among the European cluster elite. The volume of contractual research resulting from cooperation between the Institute and the employees of individual faculties is approximately 60 million CZK over a period of five years.

3) Josef Božek Automotive Industry Competence Centre: TUL is exceptionally active in cooperation on applied research projects and experimental development projects focused on the automotive industry. The core activity in this area is TUL's participation in the Josef Božek National Competence Centre for the Automotive Industry, which brings together key players in this field, such as the Czech Technical University in Prague (Faculty of Mechanical Engineering), Technical University of Ostrava (Faculty of Mechanical Engineering) and Brno University of Technology (Faculty of Mechanical Engineering). The most important industrial partners of the centre are ŠKODA AUTO a.s., TATRA a.s., TÜV SÜD Czech s.r.o. and more. Taking advantage of the experience of the departments of the FMI, the centre actively connects state-of-the-art laboratory facilities to meet the main goals, which are innovations in vehicle design, powertrains and primary power sources as a tool to reduce pollutant emissions and increase passenger comfort. The recipient of the grant is CTU.

4) Cooperation with the Ministry of Regional Development of the Czech Republic and the Czech Statistical Office: Within the TACR project (2014-2015), a methodology for estimating regional price levels was developed, and further used in the preparation of the Regional Development Strategy 2021+ (MRD) and for data reporting on regional price levels within Eurostat (CZSO). Cooperation continues even after the end of the project.

5) Association of Textile-Clothing-Leather Industry (ATOK), Czech Technology Platform for Textiles (CTPT) z. s., Cluster of Technical Textiles (Clutex) z.s.: TUL has long been working with members of these groups focused on the textile industry. Cooperation is on a strategic level and involves building concepts for the development of the textile and clothing industry. The benefit is the establishment of conditions for successful cooperation with many universities and institutions focused on textile and material engineering.

3.2 Significant cooperation in R&D&I at international level

TUL's international cooperation with foreign partners in science and research is standardised: (i) preparing and implementing international projects, (ii) organising international conferences at TUL, (iii) exchanging academic and scientific staff, (iv) organising joint workshops of cooperating workplaces, (v) internships of doctoral students at foreign workplaces and (vi) preparation of joint publications. Below is a list of the most important examples of international R&D cooperation.

1) TUL is involved in the work of the CERN-CZ research infrastructure, which organises the participation of the Czech research community in the international organisation CERN (European Organization for Nuclear Research) in Geneva. The aim of CERN-CZ is to support the development, construction, maintenance and operation of research facilities on experiments in CERN with the participation of the Czech Republic. These activities also include the operation of local research infrastructure in the Czech Republic, which is necessary for research, development and production of detectors and computing infrastructure for data processing.

Within CERN-CZ, TUL participated in the OSQAR experiment (The Optical Search for QED Vacuum Bifringence, Axions and Photon Regeneration), which aims to detect hypothetical particles - axions and to study vacuum properties. TUL significantly contributed to the development of the research strategy of the experiment.

Scientists from TUL developed optical methods for detection of predicted weakly interacting particles-axions and prepared experiments in a strong magnetic field. They

increased sensitivity of detection of individual photons in relation to the used statistical methods of data processing. They investigated possible new methods of axion detection. TUL also participated in the search for hypothetical carriers of dark energy - chameleons from the measurement of afterglow from a closed optical cavity in a magnetic field and in the analysis of OSQAR data.

Scientists from TUL improved methods for measuring very small birefringence in a magnetic field. They became founding members of the VMB @ CERN group, which brings together important world workplaces in CERN in order to investigate birefringence measurements in vacuum. TUL is cooperating with the Istituto Nazionale di Fisica Nucleare (INFN), Trieste, Italy to modernise and ensure the operation of the RICH Cherenkov radiation detector in the COMPASS experiment at CERN. This detector is a core detector for particle identification in the experiment. TUL participated in the research of gas electron multipliers for the detection of single photons in the deep ultraviolet region. TUL scientists also designed and constructed a special interferometer measuring the on-line refractive index of the gas in the RICH detector. The output is a number of joint publications describing the technological development of gas electron multipliers and articles of basic physical research in the framework of the COMPASS collaboration, describing e.g. the internal structure of a proton.

The output of the conference was a number of publications, the most important of which is a reference publication in the field of axion detection by optical laboratory experiments. Many students of Bachelor's, Master's and doctoral studies spent their internships or short-term stays at CERN as part of their studies at TUL.

For the academic teams from TUL, this cooperation means the opportunity to participate not only in basic research in a top international environment, but also to participate in the development of technologies and thus gain inspiration and stimulus for further own applied research. It also contributed to a significant modernisation of the optical laboratory at TUL. Last but not least, the cooperation greatly helped to set a promising scientific and academic careers of TUL graduates who found employment in the scientific environment in the Czech Republic (Institute of Physics - ELI beamlines,

Institute of Plasma Physics, TUL) or abroad - joint doctorate TUL-CERN, doctorate at EPFL Lausanne or are preparing a technological start-up.

2) Project Horizon 2020 No. 662177 Development and Demonstration of monitoring strategies and technologies for geological disposal (Modern2020), 2015-2019, coordinated by Agence nationale pour la gestion des déchets radioactifs (ANDRA, France): CxI and FM teams participated as partners in the project of the H2020-Euratom programme focusing on the monitoring of spent nuclear fuel in deep geological repositories. The TUL team contributed by developing energy-saving and miniaturised electronics for a combined sensor of rock environment variables and an anomaly detection algorithm in geophysical data using neural network and machine learning methods. Participation in the project was beneficial for its interdisciplinary cooperation - interconnection of IT and electro at FM with geosciences at partner workplaces.

3) Project Horizon 2020 No. 646002 Nanomaterial Fate and Speciation in the Environment (NanoFASE), 2015-2019: As part of the project, TUL participated in nanomaterial risk research. The aim of the project was to create integrated framework models and protocols for the assessment of exposure of organisms (Exposure Assessment Framework) to nano-products. The project focused on the methodology, identifying key parameters and modelling the fate of nanoparticles in soil, water and air. This approach is of purely practical importance because a uniform risk assessment approach for nanomaterials will enable industry to obtain comprehensive data on the diversity of behaviour of industrial nanomaterials and hence a standard acceptable for their regulatory registration. This activity is linked to other international and national projects.

4) Project Horizon 2020 No. 689510 A novel process for manufacturing complex shaped Fe-Al intermetallic parts resistant to extreme environments (EQUINOX), 2016-2019: The project is coordinated by the National Technical University of Athens (NTUA), Greece. The project addresses the issue of replacing steel and superalloys with materials such as chromium, nickel, molybdenum or vanadium by low-cost intermetals

such as FeAl. The aim of the project is to develop a process that will replace Cr/Ni based stainless steel with a class of high-tension FeAl-based intermetallics.

5) Project EU FP7 No. 309517 Taking Nanotechnological Remediation Processes from Lab Scale to End User Application for the Restoration of a Clean Environment: This represents the activities of TUL on an international scale aimed at the application of nanoremediation technologies in practice. Within the project, CxI scientists were responsible for WP2 "Design, Improvement and Optimised Production of Nanoparticles-Zero-Valent Iron Nanoparticles (nZVI)". The result of the project was a new type of nanoparticles that had significantly better properties compared to the present state of the art and know-how. These particles were applied at sites in Europe (Germany, Switzerland, Portugal, France, Czech Republic). The results of the project led to other international activities (services for clients in the field of application of nanoparticles at other sites as well as national activities (national projects and contractual research). The results were also presented at international conferences (also in the form of keynote speeches).

6) International project Development of Coupled models and their Validation against Experiments (DECOVALEX-2015), 2012-2015: TUL participated in a platform for joint solution, comparison and validation of mathematical models and simulation software for associated thermo-hydro-mechanical processes. Under the auspices of, and with the financial support of, the spent nuclear fuel management organisations of each country, research teams are working on uniformly assigned tasks to evaluate experimental data. The benefit is the international comparison and validation of the simulation software Flow123d developed at TUL with original numerical schemes. The results will be published in a special issue of the impacted journal after the end of the stage. The project was performed at CxI, but the main software development team is at FM.

7) Cooperation with the Royal Netherlands Meteorological Institute (KNMI), the Netherlands; Consejo Superior de Investigaciones Científicas (CSIC), Spain; and Centre of Statistics and Applications, University of Lisbon, Portugal, within the international scientific team KLIMATEXT (project EE.2.3.20.0086) brings together scientists working in

the field of mathematical statistics, climatology, hydrology and geography. The result of the cooperation is the preparation of other joint projects and publications in international peer-reviewed journals. Five joint seminars and one international conference on the Presentation of Mathematics 2014 were organised during this cooperation.

8) Global network Global University Entrepreneurial Spirit Students' Survey (GUESSS): Since 2016, EF TUL has been part of the global network GUESSS, which is led by the University of St. Gallen and the University of Bern (Switzerland), and conducts research on entrepreneurship among students. EF TUL represents the whole Czech Republic in this network. In 2016 and 2018, research was conducted on the business activities of students at Czech universities. The research results are published in the form of national and global research reports and monographs.

9) Multilateral cooperation with Brandenburg University of Technology Cottbus-Senftenberg, Germany, Tallinn University of Technology, Estonia, and Bar Ilan University, Israel. Multilateral cooperation with these universities covers the areas of circuit reliability research and testing, the use of programmable circuits and FPGA circuit design methodology, simulation and control of non-linear vibro-acoustic systems, and acoustic signal processing based on blind signal separation methods.

There is an exchange of researchers among these universities in order to exchange experience in teaching, lecturing and research, and to facilitate consultations and seminar presentations. The result of the cooperation is a series of articles in international peer-reviewed journals.

10) International scientific cooperation in the field of palaeontology. TUL has a world-class workplace studying bryozoan taxonomy and phylogeny in collaboration with Isfahan University Iran (tertiary sediment studies of Qom Formation in central Iran), the Polish Academy of Sciences (tertiary ecosystem studies in Europe and Central Asia), Woosuk University, Korean Republic (research of living Cyclostomata and Ctenostomata mosses and the first fossil finding of mosses in Korea), Oceanology Institute of Chinese Academy of Science (research on contemporary bryophytes of Qingdao Bay in eastern China). Research in this area may contribute to understanding

the course of climate changes in the early/middle Cenozoic and their impact on the fauna and is therefore relevant to current estimates of the impact of the current climate change we are facing. In 2019, TUL organised the 18th International Bryozoology Association conference in Liberec.

3.3 Mobility of academic staff and researchers

The mobility of academics and researchers is part of the TUL International Cooperation Development Strategy, of which academic and researcher mobility is a significant part, and is part of the TUL Strategic Plan and its annual updates.

Mobility system at TUL:

The mobility system at TUL has the standard concept of mobility implemented at most Czech and European universities. Mobility is divided into short- and long-term incoming and outgoing mobility. Each of these four mobility categories has its specific impact on R&D in the TUL organisational units. Long-term outgoing mobility includes, in particular, compulsory internships for doctoral students, study visits for follow-up Master's degree students, and loyalty (sabbatical) researchers' leave. The main importance of long-term outgoing mobility is the intensive professional growth of selected doctoral students and researchers. Short-term outgoing mobility includes the participation of doctoral students and researchers at international conferences and summer schools, participation in seminars and workshops at partner workplaces abroad, e.g. to perform measurements on unique experimental equipment and the infrastructure of partner sites that are not available at TUL. The main purpose of short-term mobility is to present and disseminate R&D results generated at TUL within R&D projects and secondly to create primary data as inputs for further processing at TUL. Long-term incoming mobility includes especially stays of Master's degree and doctoral students from partner universities, which are performed within the framework of Erasmus projects. The participation incoming researchers in the teaching and training process of doctoral students represents the most important outcome of the long-term arrival mobility. Long-term incoming mobility of researchers facilitates

lecturing and training of doctoral students. Short-term incoming mobility is performed mostly by leading experts and international leaders in their field.

Concept (policies) and organisation of mobility at TUL:

Conceptual mobility issues are addressed by the Deans of individual faculties in cooperation with their Vice-Deans for International Affairs and External Relations. The use and potential sharing of strategic instruments between the different organisational units is coordinated by the Vice-Rector for Science, Research and International Affairs. Specific mobility of doctoral students and academic and scientific staff is initiated and motivated by the heads of departments and supervisors of doctoral students. The incoming mobility of Master's degree students is promoted and facilitated by a system of courses/study programmes offered in English. Each incoming and outgoing mobility usually has a clearly defined research theme and target. In the case of short-term outgoing mobility, it is most often the presentation of R&D results created within the research project, which also serves as the main financial source of covering the costs of mobility. If the researcher does not have the financial resources from the project grants to cover the costs of mobility, the mobility can be supported from institutional sources. In this case, mobility enters an open tender at the university organisational unit level.

The basic criteria for the selection of mobility in the tender are

- (i) the priority of the research topic,
- (ii) the professional development of the student or researcher,
- (iii) the development of R&D cooperation (preparation of international projects or joint publications),
- (iv) lecturing;
- (v) preparation of joint degree programmes.

Selected mobility is mostly supported by the Mobility Fund of the Faculty, which is part of the Institutional Development Plan of the given organisational unit of TUL. The spending of financial resources for mobility is administered both at the level of TUL

management by the International Office and the Erasmus Office. At the TUL organisational unit level, mobility is administered by the Erasmus faculty coordinators.

The concept of mobility support in individual organisational units of TUL can be covered by the following priorities:

- (i) long-term and systematic cooperation of individual workplaces with important foreign experts and workplaces;
- (ii) to facilitate the establishment of cross-border cooperative networks to support cross-border cooperation within the Euroregion Neisse as well as other Euroregions within the reach of the faculty and university;
- (iii) to stimulate the competitiveness of Czech students under the influence of the international environment created by incoming students;
- (iv) to strengthen the international reputation of university and researchers, and enhance their quality and international competitiveness.

For an objective evaluation of the impacts of international mobility, the electronic information systems publication.tul.cz, which is used to record R&D results, and mobility.tul.cz, which is used to record the performed mobility, are used. These systems are currently innovated and integrated into a comprehensive system of evaluation of R&D results in relation to the mobility of individual researchers, research teams and workplaces.

The completion of mobility by our staff is subject to career evaluation if it is established at the university's organisational unit. The Rector's Directives regulate the conditions for taking sabbatical holidays of scientific and academic staff. The TUL Study and Examination Regulations, accreditation files of doctoral study programmes and the Dean's Directives on the organisation of doctoral study programmes of the individual organisational units of TUL determine the rules of compulsory long-term internships of doctoral students. The Dean of each individual organisational unit of TUL often determines the minimum strategic volumes of cooperation performed through the

mobility of academicians (e.g. at least 2% of academicians per year) and students (at least 10% of graduates).

The basic strategic objectives for the mobility of academicians and researchers at TUL are:

- (i) increasing the number of outgoing and incoming academic staff and students, in particular doctoral students;
- (ii) enhancing the effectiveness of collaboration arising from accomplished mobility of TUL staff on the quality of scientific work and R&D results.

The effectiveness of the accomplished mobility and the quality of incoming students and researchers is monitored through outputs from interconnected university information systems.

The following tools are used to achieve the above strategic objectives:

- (i) preparation and facilitation of joint- or double-degree programmes, especially doctoral programmes;
- (ii) increasing the number of foreign teachers;
- (iii) supporting the preparation of international projects and programmes;
- (iv) supporting the participation of students, academics and researchers in international research programmes, international competitions, and the organisation of major scientific conferences at TUL;
- (v) promoting TUL and its components in foreign languages through online information channels;
- (vi) making effective use of all available resources to cover the cost of TUL mobility: Erasmus + Mobility between Programme Countries (KA103) and International Credit Mobility (KA107), CEEPUS, Vysegrad funds, bilateral agreements between universities and interstate agreements, contribution to promoting international cooperation (Indicator D) and Mobility Fund under the Institutional Development Plan, (ix) strengthening cooperation of TUL with the Ministry of Foreign Affairs of the Czech

Republic, the Ministry of the Interior of the Czech Republic and embassies of foreign countries in the area of internationalisation, support in processing visa requirements of incoming students and researchers.

Barriers to the mobility of researchers consist mainly of (i) the workload of staff in carrying out tasks and activities within the educational process (free travel capacity is limited to periods during which regular lectures are not provided), (ii) the workload of academic and research staff on projects (the project rules do not allow time flexibility for staff if their workload is allocated to the project); (iii) a lower number of international projects at the faculty; (iv) subjective language skills concerns.

3.4 Internationalisation of the internal environment

The key topics of the internationalisation of TUL are in particular cooperation with important foreign partners, strengthening the international reputation of TUL, increasing the attractiveness for foreign industry and research partners and increasing the attractiveness for experts from abroad (potential future collaborators). We systematically support these topics to improve the quality of TUL's professional profile in terms of increasing the number of international contacts, respect and scientific performance. Effectively shared achievements in this process will contribute to greater "visibility" of the institution in the world and to the prerequisites for TUL's participation in leading international networks.

In accordance with the Strategic Plan for Internationalisation of TUL, the TUL management set the following key objectives in the area of internationalisation in R&D: (i) deepen TUL's international professional cooperation with existing major partners; (ii) establish new, working contacts with partners from the world's leading universities, R&D institutions and companies; (iii) increase the number of international projects with foreign partners and try to prepare international projects in which TUL will act as coordinator. The internationalisation of the internal environment plays a crucial role in the process of increasing the prestige of TUL in the international context.

The following strategic tools will be used to achieve the above objectives: (i) carrying out ongoing evaluations of the functioning of cooperation with existing partners, including evaluating the quality of the results of international cooperation (e.g. monitoring publications and their international response); (ii) reviewing and terminating contracts in the event of non-functioning cooperation; (iii) active search for emerging topics in R&D and search for new foreign partners to solve scientific problems at the world level of knowledge, (iii) support the preparation of joint scientific projects with foreign partners; (iv) increasing the number of students and TUL staff mobility; (v) internationalising the curriculum in connection with R&D; (vi) optimising the policy of recruiting foreign staff to internationalizes the scientific community at TUL.

The setting of strategic goals in the area of internationalisation of the internal environment of TUL is based on the identification of current shortcomings: On practical issues (e.g. availability of study and personnel materials, guidelines, etc. in Czech and English, preparation for the introduction of study programmes in English and the related preparation of accreditation, etc.) are different organisational units at different levels. The variances are given not only by the size and age of the faculty, the quality of its internal processes, its personnel resources, but also by the attractiveness of the offered fields (the more international students apply for the faculty, the faster the internationalisation of the environment progresses). Another factor is the low level of language skills of non-academic staff, their excessive workload and low financial remuneration (as a result, the capacity of professional scientists is partly used for administrative and non-scientific activities).

Examples of good practice demonstrating the level of internationalisation of the internal environment include the fact that all FTE TUL study programmes are accredited by the European Federation of Engineering National Associations "FEANI". Graduates can obtain the EURING degree after meeting other conditions of engineering practice. The cooperation of the FP TUL (namely the Department of Education and Psychology) with the University of Maine in Augusta, which is a world leader in the field of distance learning, is particularly promising. TUL has the ambition to take advantage of this existing cooperation and to become a pioneer in introducing

forms of distance education in the Czech Republic with significant active international participation throughout the entire study period.

The main barriers to the internationalisation of the internal environment at TUL include difficulties in the visa process and the related need to postpone or cancel incoming mobility due to a visa not being issued, etc.; the absence of a customer relationship management (CRM) system for communication with foreign students and staff at TUL; tuition fees for foreign students and the absence of scholarships for foreign students; shortcomings in the system of searching and recruiting from abroad; insufficient and unbalanced quality of teams (and team members) in terms of international comparison; not always relevant results of TUL teams in terms of international comparison; low representation of foreign researchers and foreign trainees at TUL workplaces; and non-systematic support of the development of the language competence of employees.

4 HUMAN RESOURCES AND CAREERS IN R&D&I

4.1 System for career growth for academic staff and researchers

TUL's personnel strategy is based on the qualification growth of academic staff, which is a precondition for the sustainability and development of disciplines and workplaces. The prerequisites and conditions for the career development of academic staff are included in the relevant regulations for different levels of management - the state doctoral examination, the habilitation procedure and the procedure for the appointment of professors. The basic framework and concept of the strategy are covered by internal regulations (Internal Wage Regulations, Rules of Quality Assurance System and Internal Quality Assessment of TUL, Rules of the Habilitation Procedure and Procedure for Appointment of Professor TUL).

All jobs are, in cooperation with the Labour Office, filled by the publication of vacancies according to the set criteria. The positions of academic staff are defined by the Higher Education Act and are carried out through open competitions.

Other TUL motivation tools are:

- Grant programmes to enhance the quality of scientific work, particularly in basic research, strengthen the prestige of international scientific teams, support young researchers and research teams and support publication activities in English.
- Support of young academics after graduation - offer of internships supported by the Mobility Fund of the TUL Institutional Development Plan, initiation of teamwork in the form of participation in the Student Grant Competition.
- Possibility of taking study leave for the preparation of habilitation and professorship procedures.

The individual faculties and institute approaches are based on the TUL umbrella concept, build on it and further develop their own strategies in accordance with the needs of individual workplaces. There are several concepts that differ in the level of processing:

1) A framework plan of qualification growth of assistant professors has been elaborated at EF and FTE. Part of the accreditation file for the habilitation procedure at EF is the setting of deadlines for habilitation. The filling of positions of the heads of departments is based on the results of open competitions for a period of four years. Associate professors and professors are tenured.

2) FP TUL creates the whole quality evaluation system, which includes the evaluation of the creative activities of academic staff. The initial version of the database was created, and standards are being set up and the pilot evaluation will be carried out in 2020. FP TUL has set tariff wages/salaries within the Wage Tariff spread to motivate employees to increase their qualifications.

3) The CxI TUL internal regulations include the CxI R&D Career Regulations, which regulate the status, evaluation and career progression. In 2020, the CxI was awarded the HR Award, where it is part of the action plan to introduce a comprehensive staff evaluation system, including a staff development system.

4.2 Evaluation system of academic staff and researchers and filling key positions in R&D&I

TUL defines the minimum qualification and professional requirements for employees in academic and research positions within the Internal Wage Regulations. Closer evaluation of employees is not centrally managed, the evaluation systems of academic and scientific staff are solved independently at each TUL organisational unit. Again, there are several evaluation approaches that differ in complexity:

(1) An academician or researcher shall be assessed on the basis of his/her outputs and results for a given period (6 months or 1 year). Participation in projects, publication outputs, outputs of applied research, etc. are evaluated and the evaluation is performed once. On the basis of this evaluation, the amount of personal or project bonus, performance or extraordinary reward is determined.

2) The system of evaluation of academic staff in science and research is based on a combination of the principle of self-evaluation and external evaluation. Each academician/researcher will select and justify one of the best R&D results for a rolling three-year period. The presented results are evaluated in the second phase by the Vice-Dean for R&D and by the Dean using bibliometric analysis (especially journal outputs) and reviews of external evaluators (especially monographs).

The filling of senior positions in R&D is closely related to the organisational structure of R&D in individual TUL organisational units, which is described in Section 4.1. The senior position in educational and R&D activities at individual TUL workplaces is held by the heads of departments or institutes. The term of office of heads of departments is usually limited to four years. The filling of senior academic positions is always organised on the basis of transparent open competition according to the Open Competition Regulations for Filling of Academic Position Vacancies and Other Job Positions at TUL. CxI Institute is linked to the Rules of Open Competition by its own regulation, which describes in more detail the procedure of this organisational unit in filling job vacancies.

TUL may also launch an internal open competition if necessary to select the most suitable internal candidate for a job created e.g. due to mobility or a new project.

4.3 Recruitment system for academic staff and researchers from the external environment

In terms of the external recruitment system, TUL and its organisational units use standard processes of open competition. Open competition is announced according to the requirements of the given organisational unit and in relation to the vacant position, but always keeps the process transparent and publicly available in order to find the best candidate for the position. In the Czech Republic, open competition is published through the national employment portal of the Ministry of Labour and Social Affairs, from which other work servers (e.g. pedagogem.cz) take over the data, and on the TUL website.

When recruiting and addressing potential candidates for the desired job position in R&D (from the Czech Republic and abroad), contacts to universities, universities and research institutes with which TUL cooperates are utilized. In addition, notices of competitions for the vacant job positions of research and academic staff are published on the TUL notice board.

When recruiting academics or researchers from abroad, TUL uses the Euraxess and ResearchGate job portals. Jobs for foreign employees are in most cases research-oriented, often in the framework of acquired projects. In most cases, these employees are only employed for the duration of the research project. For 2020, TUL would like to focus more on identifying new suitable foreign recruitment agencies that would allow us to base our selection procedures on a wider range of candidates or international academic recruitment agencies. This standard process of recruiting and selecting academic and scientific staff can be further refined by directives at individual organisational units.

A CxI Directive lays down rules on the composition of the selection committee, including an emphasis on its gender balance and the participation of experts from abroad. The Directive clearly sets out the selection criteria through scoring. The open competition is usually two-round. Part of the Directive is also the Rules of Procedure of

the Selection Committee to fill the positions of heads of research departments CxI. In 2020, the CxI was awarded the HR Award, which included an action plan to make recruitment more attractive, with a focus on greater transparency and attracting researchers from abroad.

4.4 Human resources structure

The physical number of TUL employees in academic and scientific positions decreased by 9 % in the reporting period. Conversely, the recalculated number of employees in these positions is developing positively and compared to 2014, the number has increased by 6 %.

There were no major changes in the age and qualification structure during the 2014-2018 reporting period. Most professors (about 70 %) are older than 60 years. A positive trend is seen in the acquiring of professorships of employees under 50 years of age. Another positive trend is the increase in the number of TUL employees in associate professorships, which resulted in an increase of 6.6% in this category and an equal age distribution in this category (approximately 25% in the 40-69 age group). In 2018, there was an increase in the number of women in the positions of associate professors by seven.

The position of assistant professors shows the opposite trend, with the number of employees in this category decreasing by 12 %. The highest share of employees (approximately 70 %) in the positions of assistant professors is in the age group 30-49 years old. There was no increase in the number of researchers; 50 % of employees are 30-39 years old. Unfortunately, the number of women in these positions decreased by 15 %. In 2014 and 2018, according to the Internal Wage Regulations, TUL had no position of a researcher involved in teaching activities; therefore, the values in Tables 4.4.1 and 4.4.2 are zero.

Post-docs were not monitored or reported in 2014-2017, there was no methodology. For this reason, the table shows employees who were employed and who also received a Ph.D. within five years of the survey. In the same way, the data for the year 2018 were also quantified so that the set of data had a meaningful value. Post-docs and

doctoral students are a subset of the other categories. Until 2017 inclusively, the numbers of assistant professors with scientific rank and assistant professors were added into one category and reported to assistant professors in all statistics where it was necessary to register academic staff at TUL. Lecturers are reported in the category of assistants. TUL is still looking for suitable employees from abroad, but there was no significant change between 2014 and 2018. Foreign nationals (excluding Slovak) represent about 5% of TUL's academic and scientific staff.

As a specific TUL organisational unit with its own Human Resources Development Unit, CxI agreed to the principles of the Charter and the Code through the Declaration of Commitment to the European Charter for Researchers and the Code of Conduct for Researchers on 5 December 2017. In 2020, CxI was awarded the HR Award, through the OP RDE project called CxI TUL Management Mechanisms with an emphasis on improving the quality of R&D results. The key document of HRS4R is the analysis of the CxI environment, the so-called GAP analysis and the subsequent Action Plan.

While the GAP analysis compares current practice and conditions for CxI with the requirements of the Charter and the Code, the Action Plan proposes actual solutions - actions for the shortcomings.

Together with the other documents, the document "Recruitment based on the principles of openness, transparency and merit criteria" was elaborated. The recruitment strategy will be subsequently developed.

4.4.1 Age structure of university staff contributing to R&D&I and their structure by job classification and gender in 2014 (numbers of physical employees and workers)

Academic/ professional position	29 or under		30 – 39 years		40 – 49 years		50 – 59 years		60 – 69 years		70 or over	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Professors	0	0	0	0	3	0	18	0	18	2	29	0
Associate professors	0	0	14	1	14	5	26	5	33	7	19	3
Assistant professors	40	23	211	69	106	59	62	39	39	20	12	4
Assistants	6	4	12	4	3	0	2	1	2	2	0	0
Scientific, research and development staff contributing to teaching	0	0	0	0	0	0	0	0	0	0	0	0
Postdoctoral fellows	6	6	87	25	15	11	5	4	0	0	0	0
Ph.D. students	10	7	0	0	0	0	0	0	0	0	0	0
Other scientific, research and development staff	30	9	55	14	18	8	1	0	3	0	1	0
Scientific staff outside the above categories	0	0	0	0	0	0	0	0	0	0	0	0

Note: This is the total number of employees/workers as at 31 December of the calendar year in question (in full-time or part-time employment, excluding persons with contracts for services or contracts for work). They do not include other contractual arrangements under the Civil Code concerning the purchasing of services.

Table 4.4.2 Age structure of university staff contributing to R&D&I and their structure by job classification and gender in 2018 (numbers of physical employees and workers)

Academic/ professional position	29 or under		30 – 39 years		40 – 49 years		50 – 59 years		60 – 69 years		70 or over	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Professors	0	0	0	0	6	0	11	0	21	1	21	1
Associate professors	0	0	10	2	26	6	31	13	26	6	20	3
Assistant professors	12	8	145	44	145	66	67	40	36	22	6	1
Assistants	1	6	6	4	3	0	1	1	5	1	2	0
Scientific, research and development staff contributing to teaching	0	0	0	0	0	0	0	0	0	0	0	0
Postdoctoral fellows	2	2	62	15	12	6	8	4	1	1	0	0
Ph.D. students	10	4	0	0	0	0	0	0	0	0	0	0
Other scientific, research and development staff	0	0	0	0	0	0	0	0	1	1	0	0
Scientific staff outside the above categories	36	11	51	18	13	8	5	2	2	0	0	0

Note: This is the total number of employees/workers as at 31 December of the calendar year in question (in full-time or part-time employment, excluding persons with contracts for services or contracts for work). They do not include other contractual arrangements under the Civil Code concerning the purchasing of services.

4.4.3 Staff contributing to the university's R&D&I who were foreign nationals in 2014 and 2018, other than Slovak nationals (average converted numbers)

Academic/professional position	Total 2014	Of whom women	Total 2018	Of whom women
Professors	2.12	0	1.3	0
Associate professors	3	1	3.25	2
Assistant professors	22.75	4.35	13.53	9.25
Assistants	1	1	1	1
Scientific, research and development staff contributing to teaching	0	0	0	0
Postdoctoral fellows	11.2	1.8	6	2
Ph.D. students	0	0	0	0
Other scientific, research and development staff	0	0	0	0
Scientific staff outside the above categories	0	0	9.22	0.295
Total foreign nationals	28.87	6.35	28.3	12.545

Note: The average converted number is the proportion of the total number of hours worked over the monitoring period from 1 January to 31 December by all workers (including contracts for work but excluding contracts for services) and the total annual working hours of a full-time employee

4.5 Gender equality measures

The recruitment process at TUL is transparent, taking into account the candidate's competence, knowledge and skills, and not gender differences. During the employment relationship, the ability of the employee is equally important, thanks to which he/she/whoever can achieve career advancement following academic degrees and success in scientific/research work as project investigators or research team leaders or as department head or another senior position. The career path is not codified yet. Increasing qualifications and improvement within one's own expertise belongs to the workload of both academicians and researchers.

Employees of all possible sexes are allowed to use the day care services provided by TUL: short-term babysitting for children up to 3 years of age, kindergarten, children's clubs, including holiday camps, in order to have the possibility of quality childcare

during working hours. Employees on parental leave who are interested in a progressive return to working life, may gradually return to an eight-hour weekly job as needed.

Working time for academicians and researchers is flexible, subject to agreement with the senior manager. Academicians are entitled to 40 days of leave and researchers are entitled to 30 days of leave (i.e. an additional 10 days to the statutory entitlement under the Labour Code).

Employees may attend language courses or lifelong learning courses. TUL also provides benefits to employees in the area of assistance in dealing with difficult life situations and within the Academic Advisory Centre and Assistance Centre, employees can visit a university psychologist or take advantage of legal services.

TUL has employee dormitories, which are more temporarily forms of accommodation for employees (domestic and foreign) before the employee adapts to the Liberec region. International office employees are in charge of expatriate services, i.e. to assist foreign employees not only with communication with authorities, but also in common life situations in the Czech Republic.

In 2018, TUL issued a Code of Ethics for TUL employees and students, setting out general moral rules that are obligatory and natural for all university staff. Violations of these rules are resolved by the appointed ethics committee.

5 FUNDING FOR R&D&I

5.1 Structure of funding for R&D&I

Scientific and research activities at TUL have historically been very closely linked to cooperation with industry, in particular regional industrial enterprises. A large share of research and development topics addressed by TUL is initiated by the requirements of our industrial partners. This long-term trend corresponds to the structure of expenditure on basic research (24%) and applied research, experimental development and innovation (76%), as shown in Table 5.1.1. The consequence of the application focus of TUL and the low volume of funds spent on basic research with respect to applied research expenditures results in lower values of bibliometric indicators of TUL,

which are monitored within module M2 of the M17 + methodology. Less funding for basic research does not allow TUL to create a unique experimental infrastructure that could be a source of state-of-the-art results in the world. This results in a very low citation rate of TUL scientific publications, although the total number of publications corresponds to the average values of other universities in the Czech Republic.

The situation in applied research is diametrically different. According to the European Patent Office’s STAPAT database, TUL, with 162 patents and 197 citations, ranks first among all universities in the Czech Republic. Patent citations may be seen as proof of their technological topicality and relevance. The results of the citation of TUL patents are proof that in the area of applied research we are able to identify and solve problems that have a significant social and economic impact.

Table 5.1.2 shows projects supported by a provider from another country.

The following prestigious international projects were performed at TUL in the reporting period:

1) Project MSCA-ITN-ETN No. 764902 Smart Tomographic Sensors for Advanced Industrial Process Control (TOMOCON), 2017–2021, investigator: Helmholtz-Zentrum Dresden-Rossendorf Ev (Germany): The project is focused on the use of industrial tomographic sensors for the control of technological processes, especially those that need to be modelled as distributed parameter systems.

2) Office of Naval Research Global N62909-19-1-2105 Advanced Methods for Blind Extraction of Independent Sources from Multi-Sensor Observations (2019-2021) and N62909-18-1-2040 Extraction (2018): Blind signal separation projects focusing on passive monitoring of acoustic signal sources.

Table 5.1.1 Proportion (%) of total costs/expenditure by type of R&D&I funded from public and non-public sources

	2014	2015	2016	2017	2018	Total
Basic research	18	26	33	27	20	24
Applied research	74	69	61	64	71	68
Experimental development and innovation	8	5	6	9	10	8
Total	100	100	100	100	100	100

Note: Under Section 2 of Act No 130/2002, basic research refers to theoretical or experimental work performed largely for the purpose of gaining new knowledge of the basic principles of phenomena or observable reality, and is not primarily aimed at any practical application or use.

Innovation refers to the introduction of new or substantially improved products, processes or services.

For other definitions see OECD Fields of Research and Development (Frascati Manual 2015).

Table 5.1.2 Projects supported by a provider from another country

As the beneficiary							
Provider/ Investor	Programme/ Subsidy scheme	Project title	Support (EUR thousand)				
			2014	2015	2016	2017	2018
EC	Teaming	Multifunctional Nanoparticles and Materials Controlled by Structure	0	0	95	0	0
Total			0	0	95	0	0
As another participant							
Provider/ Investor	Programme/ Subsidy scheme	Project title	Support (EUR thousand)				
			2014	2015	2016	2017	2018
EC	Interreg Europe	Integrated Approach to Management of Groundwater quality in Functional Urban Areas	0	0	5	90	76
EC	Interreg Europe	Alliance for Advanced Manufacturing in Central Europe	0	0	0	15	36
EC	7RP	Assessment and mitigation of NM-enabled product risks on human and environmental health: Development of new strategies and creation of a web-based guidance tool for nanotech industries	22	25	39	13	0
EC	HORIZONT 2020 Euroatom	Development and Demonstration of monitoring strategies and technologies for geological disposal	0	10	19	20	19
EC	HORIZONT 2020 Euroatom	Development of the safety case knowledge base about the influence of microbial processes on geological disposal of radioactive wastes	0	15	77	83	85
EC	7RP	Framework to respond to regulatory needs of future nanomaterials	34	24	39	52	0
EC	HORIZONT 2020	Nanomaterial Fate and Speciation in the Environment	0	6	18	28	29
EC	7RP	Taking Nanotechnological Remediation Processes from Lab Scale to End User Application for the Restoration of a Clean Environment	82	84	149	6	0
EC	7RP	Study of Strongly Interacting Matter (HADRONPHYSICS3)	1	0	0	0	0
EC	HORIZONT 2020	A novel process for manufacturing complex shaped Fe-Al intermetallic parts resistant to extreme environments	0	0	88	96	96
Total			140	162	434	403	341

Note: List individual consortium projects financed from EU framework programmes (FP 7,¹ Horizon 2020² – excluding the ERC and MSCA, FP 9,³ etc.) and the level of funding in euro (for collaborative projects, list

¹ The Seventh Framework Programme for Research and Technological Development (FP 7) was the European Union's main instrument for financing European research in 2007–2013.

² Horizon 2020, the eighth framework programme for research and innovation (H2020), is the largest programme under EU structures for financing science, research and innovation in 2014–2020.

³ The planned ninth EU framework programme for research and innovation (Horizon Europe) will replace Horizon 2020 and should operate in 2021–2027.

the funding for the university), prestigious individual projects (ERC, MSCA, HHMI, HFSP, etc.) and the level of funding in euro (for this category of projects, additional information can be included at the university's discretion, e.g. specialisation, other project participants, any other relevant information), other foreign consortium projects and the level of funding in euro (HHMI, NIH,⁴ Wellcome Trust,⁵ etc.). For collaborative projects, only list the funding for the university.

Table 5.1.3 Projects supported by a provider from the Czech Republic

As the beneficiary							
Provider/ Investor	Programme/ Subsidy scheme	Project title	Support (EUR thousand)				
			2014	2015	2016	2017	2018
GAČR	Standard projects (1993 - 2050)		223	234	403	244	386
GAČR	Junior grants (2015 - 2022)		0	0	42	46	48
TAČR	Alfa		1 741	1 843	1 456	877	0
TAČR	Epsilon		0	0	23	694	1 259
TAČR	Éta		0	0	0	0	51
TAČR	Gama		43	153	154	162	162
TAČR	Omega		54	56	105	107	0
TAČR	Théta		0	0	0	0	23
TAČR	Zéta		0	0	0	17	65
MPO	Applications	Dynamic multi-axis electrohydraulic heat recovery units	0	0	0	29	26
MPO	Applications	Modular system of polluted water treatment	0	0	0	0	35
MPO	Applications	Sky Paragliders a.s. - Research and development of new technical fabric for aircraft rescue systems	0	0	0	14	16
MPO	Applications	Special clothing and textile products of high utility properties based on a new generation of intelligent materials that will increase health and social efficiency care for the elderly.	0	0	0	10	4
MPO	Applications	Management Support System (SMP)	0	0	0	0	7
MPO	Applications	Development and utilization of multicomponent biosurfactants in waste decontamination	0	0	0	2	6
MPO	Applications	Development of operating system and application layer for 2nd generation communication unit for automotive	0	0	0	0	6
MPO	Applications	Knowledge base for decommissioning of nuclear power plants	0	0	0	14	19
MPO	Knowledge transfer partnerships	Construction of actively controlled pram using modern technologies	0	0	0	6	14
MPO	Knowledge transfer partnerships	Modular system of polluted water treatment	0	0	0	0	9
MPO	Trio		0	0	0	9	81
MPO	Inovace – Patent		2	0	0	0	0
MPO	Tip		440	60	0	0	0
ERN	PS ČR - Poland		0	0	0	0	7
MK	NAKI		195	54	53	58	0
MŠMT	InterExellence		0	0	0	3	10

⁴ National Institutes of Health (NIH) – an agency that is part of the United States Department of Health and Human Services. NIH is also an important actor in project support for biomedical research.

⁵ A major British charity that chiefly supports biomedical research.

MŠMT	OP VaVpl	Application of nanomaterials and progressive technologies	742	450	-2	0	0
MŠMT	OP VaVpl	Innovative products and environmental technologies	491	319	-2	0	0
MŠMT	OP VaVpl	Nanofibrous materials for tissue engineering	528	341	0	0	0
MŠMT	OP VaVpl	New technologies and special machine components	312	244	-5	0	0
MŠMT	OP VVV	3D STAR - 3D printing in construction and architecture	0	0	0	0	396
MŠMT	OP VVV	Hybrid materials for hierarchical structures	0	0	0	0	1 382
MŠMT	OP VVV	Modular platform for autonomous bogies of specialized electric vehicles for freight and equipment transport	0	0	0	0	133
MŠMT	National Sustainability Program I (2013 - 2020)		1 063	1 428	1 363	1 422	1 147
MV	VG - Security research		304	0	0	0	0
MV	VI - Security research		0	35	137	533	536
MZ	Support of medical applied research (2015 - 2022)		0	60	82	81	79
Total			6 137	5 277	3 809	4 326	5 906
As another participant							
Provider/ Investor	Programme/ Subsidy scheme	Project title	Support (EUR thousand)				
			2014	2015	2016	2017	2018
GAČR	Standard projects (1993 - 2050)		199	240	210	247	253
TAČR	Alfa		938	788	537	268	0
TAČR	Delta		0	0	118	134	82
TAČR	Epsilon		0	523	585	1 005	1 037
TAČR	Éta		18	0	0	0	0
TAČR	Théta		0	0	0	0	15
TAČR	Zéta		0	0	0	0	26
TAČR	Centers of competence (2012 - 2019)		385	400	377	337	287
MPO	Applications	Dynamic multi-axis electrohydraulic heat recovery units	0	0	19	43	16
MPO	Applications	Integration of microcomputers into lighting systems	0	0	0	0	10
MPO	Applications	Construction of actively controlled pram using modern technologies	0	0	0	35	22
MPO	Applications	Modular system of polluted water treatment	0	0	0	150	124
MPO	Applications	New process of functionalization and coating of materials in the form of powders or finished bodies	0	0	21	23	0
MPO	Applications	Industrial research and experimental development of a small urban electric car and tools for its production	0	0	0	0	66
MPO	Applications	Sky Paragliders a.s. - Research and development of new technical fabric for aircraft rescue systems	0	0	0	26	31
MPO	Applications	Smart textiles	0	0	0	5	33
MPO	Applications	Special clothing and textile products of high utility properties based on a new generation of intelligent materials that will increase health and social efficiency care for the elderly.	0	0	0	17	8
MPO	Applications	Management Support System (SMP)	0	0	0	0	15

MPO	Applications	Development and utilization of multicomponent biosurfactants in waste decontamination	0	0	0	23	31
MPO	Applications	Development of operating system and application layer for 2nd generation communication unit for automotive	0	0	0	1	74
MPO	Applications	Development of textile products from non-combustible and recyclable materials	0	0	0	0	154
MPO	Applications	Research and development of innovated cutting tool surfaces using carbon nanoparticles	0	0	0	29	111
MPO	Applications	Test site for pre-certification tests	0	0	0	36	42
MPO	Applications	Knowledge base for decommissioning of nuclear power plants	0	0	0	19	30
MPO	Knowledge transfer partnerships	Admixture detection specialist	0	0	0	42	37
MPO	Trio		0	0	397	1 129	1 442
MPO	Tip		657	180	15	0	0
MŠMT	6. FP EU		0	0	3	3	0
MŠMT	7. FP EU		28	26	26	0	0
MŠMT	8. FP EU		1	2	0	0	0
MŠMT	9. FP EU		0	1	0	0	0
MŠMT	10. FP EU		0	1	0	0	0
MŠMT	COST		30	34	27	0	0
MŠMT	EUPRO II (2011 - 2017)		69	70	89	85	0
MŠMT	Eureka		9	7	20	22	0
MŠMT	Gesher/Most		12	23	0	0	0
MŠMT	INGO		19	19	5	6	0
MŠMT	InterExellence		4	4	3	192	210
MŠMT	Kontakt II		13	17	19	0	0
MŠMT	Large R&D&I infrastructures (2010 - 2022)		0	0	165	172	194
MV	VG - Security research		37	32	0	0	0
MV	VI - Security research		0	53	151	165	139
MZ	Support of medical applied research (2015 - 2022)		0	0	0	0	34
Total			2 420	2 420	2 786	4 215	4 519

Note: List total Czech Science Foundation projects and the level of funding in euro, total Technology Agency of the Czech Republic projects and the level of funding in euro, and total other state-funded projects and the level of funding in euro. For collaborative projects, list the funding for the university.

Please also list individual projects financed from EU structural funds and targeted exclusively at R&D&I (e.g. OP RDE, ⁶ OP EIC⁷) and the level of funding in euro, and individual projects financed from regional funds targeted exclusively at R&D&I and the level of funding in euro. For collaborative projects, only list the funding for the university.

Table 5.1.4 Projects supported from non-public sources

As the beneficiary

⁶ Operational Programme Research, Development and Education – a multiyear programme coordinated by the Ministry of Education, Youth and Sports. Under OP RDE, funding can be drawn in the 2014–2020 period from the European Structural and Investment Funds (ESIF).

⁷ Operational Programme Enterprise and Innovation for Competitiveness – a multiyear programme coordinated by the Ministry of Industry and Trade for drawing funding from the European Regional Development Fund (in the 2014–2020 period).

Provider/ Investor	Project title	Support (EUR thousand)				
		2014	2015	2016	2017	2018
TAČR	Filtration systems with biocatalytically active nanofiber materials for drinking water treatment	0	0	0	23	19
TAČR	Chemosensory Perception and Development of its Measuring Device.	0	0	0	1	0
TAČR	Advanced additives implementation into production of extruded composite profiles used by progressive additive technologies in area of 3D printing.	0	0	0	15	15
TAČR	Information System for Analysis and Assessment of Groundwater Resources in Dependence on Human Activities and Climatic Changes	0	0	0	11	0
TAČR	Food Industry Wastewater Treatment Using Membrane Filtration	0	0	0	6	6
TAČR	Microbial colonization of the fiber surface for analytical and diagnostic practice and technical applications	0	0	0	4	0
TAČR	Nanofibrous systems for drug delivery with sustained released.	0	0	0	20	16
TAČR	Low-cost water treatment systems	0	0	0	3	7
TAČR	Regeneration of wells - new targeted regeneration processes, regeneration and monitoring systems, and preventive diagnosis of the state of wells	0	0	0	3	10
TAČR	Software for Complex and Stochastic Modelling in Hydrogeology	0	0	0	0	36
TAČR	Software for simulation and analysis of geosphere processes	0	0	0	48	0
TAČR	Broadband components with resonant nanofibrous membrane for room acoustics	0	0	0	12	11
TAČR	Wound cartridge filters from nanofibrous composite yarns	0	0	0	3	4
Total		0	0	0	149	125
As another participant						
Provider/In vestor	Project title	Support (EUR thousand)				
		2014	2015	2016	2017	2018
TAČR	ADDITIVE TOOLS OF WASTEWATER BIOREMEDIATION	0	0	0	5	5
TAČR	Active Nanofibrous Membranes for the Waste Water Cleaning	0	0	0	4	0
TAČR	Antimicrobial plasters based on nanofibers modified by nanoparticles	0	0	0	0	32
TAČR	Autocalibration early warning system against the effects of the increasing groundwater level during the flood	0	0	0	0	12
TAČR	Biodegradable silk fibroin based materials for orthopedics	0	0	0	1	18
TAČR	Landfill leachate treatment with combined membrane technology using of biological pre-treatment process	0	0	0	2	1
MPO	Dynamic multi-axis electrohydraulic heat recovery units	0	0	0	29	0
TAČR	Environmental friendly nanotechnologies and biotechnologies in water and soil treatment	0	0	0	29	29
TAČR	Expert system for monitoring, risk assessment and decision support in the field of land use	0	0	0	5	9
TAČR	Functional development of bi-system liquid filter for recycling of process water using modern methods of modelling	0	0	0	4	4
MPO	Construction of actively controlled pram using modern technologies	0	0	0	6	14
MPO	Modular system of polluted water treatment	0	0	0	0	35
TAČR	New technologies and materials for groundwater treatment on basis of biogeochemical processes (BIOGEOCHEM)	0	0	0	2	1
TAČR	Sophisticated hybrid tapes for fabrication of composites by precise winding	0	0	0	3	10
TAČR	Advanced in situ remediation technologies supported by the electric field	0	0	0	4	0
TAČR	Advanced real-time controlling and monitoring of remediation technologies (RealControl)	0	0	0	0	6
TAČR	Advanced technologies for heat and electricity production	0	0	0	11	10
TAČR	Key manufacturing technologies and industrialization of high performance composite with glass fibers for the wind turbine blades	0	0	0	8	0
MPO	Senior Tex - Smart Modular clothing and textile products with integrated electronic microsystems for improving the health care of the aging population and handicap people	0	0	0	2	2

MPO	Sky Paragliders a.s. - Research and development of new technical fabric for aircraft rescue systems	0	0	0	14	16
MPO	Smart textiles	0	0	0	0	10
TAČR	Software for the evaluation of radionuclide migration on the geosphere - biosphere interface and its impact on a man	0	0	0	0	34
MPO	Sorption module for nuclear power plant severe accident mitigation	0	0	0	4	7
MPO	Special clothing and textile products of high utility properties based on a new generation of intelligent materials that will increase health and social efficiency care for the elderly.	0	0	0	10	4
MPO	Management Support System (SMP)	0	0	0	0	7
TAČR	Fast Reactive Power Correction System with Easy-to-Integrate Features for Plants with High Degree of Automation	0	0	0	0	12
TAČR	Technology of microorganism-free surfaces of nanotechnological materials for biotechnology applications	0	0	0	0	4
MPO	Effect of long-term heat pumps operation on the sustainability of rock environment energy potential	0	0	0	3	3
TAČR	Development and testing of a method of thermally enhanced in-situ anaerobic bioremediation of chlorinated contaminants in subsoil (Thermo-Bio-Rem)	0	0	0	2	1
TAČR	Development burner gas infrared heater on the principle of kinetic combustion	0	0	0	0	4
TAČR	Development of tools for studying contaminant transport in fractured rock environment	0	0	0	3	3
TAČR	The development of advanced variable membrane technology for treating various types of industrial wastewater with poor bio-treatability	0	0	0	2	2
TAČR	Protocol development on highly effective nitrogen removal process from waste and underground water based on denitrification exogenous substrates	0	0	0	5	5
TAČR	Development of the system for asymmetrical fault location V-dip	0	0	0	0	2
TAČR	Development of quick changeover means for sorting screens production preparation machine	0	0	0	4	4
MPO	Development of textile filtration hose containing nanofibers	0	0	0	0	4
MŠMT	Wearable IoT	0	0	0	3	10
TAČR	Implementing of the advanced augmented reality methods as one of the Industry 4.0's pillars into designing and developing an industrial product	0	0	0	1	2
MPO	Knowledge base for decommissioning of nuclear power plants	0	0	0	3	8
Total		0	0	0	171	328

5.2 Support for obtaining foreign research projects

In two organisational units of TUL (Cxl and FM), support of research teams in the submission of research projects is provided through the faculty Grant Support Department (GSD). GSD staff actively search for international calls and relevant call information is distributed to appropriate workplaces. Information about a call includes its basic parameters (main topics, technical readiness level (TRL) at the beginning and end of the project, composition of the consortium, support rate, eligible costs, and budget). Then the research teams are provided with full administrative service by financial managers who have received training on international projects in the Czech Republic (Technology Centre) but also abroad (European Commission).

6 FORMATIVE EVALUATION OF R&D&I AND THE START-UP STRATEGY (WITH POTENTIAL FOR APPLICATION)

6.1 Internal and external system for evaluating research units

Systematic internal and external evaluation of all research units at TUL has been limited in the past. Most often, the evaluation of a team was carried out within the evaluation of large research projects by checking the fulfilment of quantified indicators of these projects. Due to the different character of the indicators, their monitoring enabled a multi-parameter evaluation of individual research units to be created. These were the development of workers, both in terms of numbers and qualifications, the number of research projects implemented, international projects, the number of results (articles and applied results), the use of instrumentation, cooperation with industry. External evaluations were provided by independent evaluators of these major projects.

As of 2017, the internal regulation of the TUL Quality Assurance System and Internal Quality Assessment Rules applies. Based on this, individual organisational units create their own quality evaluation systems that correspond to their specific requirements and characteristics and which include the evaluation of research activities.

6.2 Conditions for setting up new teams and introducing new research topics (start-up strategy)

TUL has adopted a standard strategy for identifying new research themes and setting up new teams that are common at European universities. The basic tool for searching emerging themes is

- (i) active participation of researchers in prestigious international conferences,
- (ii) continuous monitoring of state-of-the-art in the field through continuous study of literature published in prestigious international journals,
- (iii) active participation in international workshops at major scientific academic and other research institutions.

In the event that a new perspective theme is identified, and is suitable for solution at a TUL workplace, administrative steps are taken to further anchor the theme and support the newly formed team. A key tool for the development of the theme is to establish international cooperation with a leading workplace of the theme in Europe, or where, at least, the theme is significantly elaborated. In the event that the theme shows qualities enabling its commercialisation, the next step will be the involvement of a carefully chosen industrial partner, who would be interested in the results in the theme and which is a guarantee of its subsequent use.

In the initial period before the grant (or other) financial resources for the research of the new theme are obtained, the scientific activities are financed from the workplace's budget, most often from the LCDRO. In the case of an exceptionally high-quality basic research theme, the team may apply for support under the TUL Grant Programmes.

The equipment of the workplace is available for the new team. An internal database of instrumentation is available at TUL for efficient sharing. Powerful computing and data servers (in cooperation with CESNET) may be shared at TUL. The eduld.cz website provides the working team with access to the usual databases of world scientific literature.

6.3 External advisory bodies for R&D&I, independent feedback for R&D&I

With effect from 2 August 2019, the TUL Statute establishes the International Board of TUL. The activities, composition and proceedings of the TUL International Board (IB) are established in the Statute of the IB valid from 15 November 2019. The members of the International Board were appointed by the Rector of TUL from 27 March 2020.

6.4 System for acquiring and renewing instruments and equipment for R&D&I

Costly instruments are acquired and renewed continuously according to the requirements and needs of workplaces. Equipment innovation and development is strategically planned in yearly intervals during the period of preparation of the fund allocation plan. The research teams at individual TUL organisational units initiate the acquisition or renewal of instrumentation through the workplaces. These initiatives are strategically divided into two categories: (i) long-term investments and (ii) priority

investments. Funding from the Structural Funds, European projects and research projects is used to acquire or renew expensive equipment in the long term. The acquisition or renewal of priority instruments is planned from the Fixed Assets Development Fund (FRIM). Acquisition of equipment is carried out mainly through tenders.

Table 6.4.1 lists all costs/expenditures corresponding to the definition of research infrastructure, irrespective of the financial source from which they were funded, related to R&D&I. The research infrastructure is established by the Framework for State Aid for Research, Development and Innovation (2014/C 198/01) and Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty Text with EEA relevance.

Table 6.4.1 shows the expenditure accumulated from institutional support (LCDRO) and targeted grants and used to purchase the research infrastructure. The value of these expenditures is in principle limited by the size of the TUL. It is evident that these limited expenditures did not allow to purchase or build worldwide unique experimental equipment, which would enable to produce in a straightforward way excellent results of basic research in the field of natural and technical sciences.

Table 6.4.1 Overview of expenditure/costs for the research infrastructure and equipment in the 2014–2018 reporting period (including related non-investment and personnel costs).

Costs/expenditure (EUR thousand p.a.)	2014	2015	2016	2017	2018	Total assets value
Total costs/expenditure related to purchasing low-value fixed assets for R&D&I	294	244	414	1 001	562	2 514
Costs of equipment repair and maintenance	150	175	236	226	240	1 026
Purchasing tangible and intangible fixed assets for R&D&I (investments)						
Of which: software	71	27	130	375	189	792
Of which: other intangible fixed assets	0	7	79	92	9	187
Of which: land, buildings and structures	420	169	0	31	39	659
Other tangible fixed assets (machinery, instruments, equipment, etc.)	2 727	871	1 030	7 791	4 315	16 734
Total expenditure on infrastructure for the year	3 662	1 491	1 889	9 516	5 355	21 913

6.5 System for sharing instruments and equipment for R&D&I

The instruments and instrument sets are recorded in the TUL property register and instrument logs are made for them. The instruments are located in the laboratories of the individual research workplaces and are managed by the appointed workers of the workplaces. It is the responsibility of the workplace to organise the sharing of the instruments. If the nature of the facility permits, we seek to integrate it into external collaborative research infrastructures above TUL. The acquired instruments sets can be shared not only by all workplaces of the given organisational unit, but also by other workplaces of TUL and, of course, also by external subjects, if the process of acquisition of the research infrastructure permits.

Information about the instruments is available on the web pages of the TUL organisational units and also on information brochures of individual laboratories. External subjects are informed about the possibility of sharing TUL equipment at seminars, conferences, open days, scientists' nights, etc.

7 GOOD PRACTICE IN R&D&I

7.1 Internal regulations and measures for maintaining good practice in R&D&I

In 2018, TUL issued a Code of Ethics for TUL employees and students, setting out general moral rules that are obligatory and natural for all university staff. Violations of these rules are resolved by the appointed ethics committee. In the area of R&D, the TUL Code of Ethics addresses, inter alia, plagiarism, duplication of research, fragmentation of results, protection of intellectual property, fair recognition of colleagues' contribution, conflict of interest situations, adherence to publication ethical rules, resolution of published errors.

The TUL Library has up-to-date lists of so-called predatory journals and provides support to TUL researchers in the effective dissemination of results in international peer-reviewed journals. In support of quality research and publishing, the TUL Library offers an online tool for discovering the scientific plagiarism - Similarity Check, which is used to check not only student theses but also habilitation theses.

7.2 Open Access strategy for information from R&D&I

Since 2014, TUL has been operating the Dspace repository (<http://dspace.tul.cz/>), where TUL university theses are freely accessible. The TUL repository is offered to academicians and students as a secure persistent repository for the results of their scientific work. The TUL Library regularly participates in the Open Access Week (<http://www.openaccessweek.org/>).

Since 2019, an agreement has been concluded with the Swiss publishing house MDPI, the so-called Institutional Open Access Programme. Thanks to this agreement, TUL authors received a 10% discount on publishing fees for this publisher. The TUL Library staff provide information about Open Access, can recommend specific Open Access journals from individual fields, or check the credibility of Open Access journals or conferences.

TUL publishes scientific journals ACC Journal and E+M, which belong among open access journals. TUL is a member of the international consortium SCOAP3, an international association of more than a thousand libraries and research centres from more than 24 countries that, in cooperation with key publishers, promotes open access to scientific articles in the field of nuclear and subnuclear physics.

7.3 Data Management strategy for research data

The research data management strategy is not formalised at TUL. Actually available resources are used for this purpose, especially CESNET data storage and Google Drive for smaller volumes. The protection of intellectual property, personal data and the ethics of working with data are defined by the relevant Rector's guidelines.