ICT

Institute
of Chemical
Technology,
Prague,
Czech Republic

ICT PRAGUE

The Institute of Chemical Technology, Prague

PAST
PRESENT
FUTURE

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Preface

PREFACE

Dear Reader,

Welcome to the prospectus of the Institute of Chemical Technology, Prague (ICT Prague).

As a member of the family of the 26 universities in the Czech Republic, ICT Prague is a university with a brilliant history, a strong current position, and good prospects for the future.

ICT Prague is justly proud of its long and important contribution to European higher education. It emerged from the glorious tradition of the oldest university north of the Alps and east of the Rhine; from the celebrated Charles University founded in Prague, as early as 1348, by Charles IV, King of Bohemia and Holy Roman Emperor. More specifically, it grew out of the engineering courses delivered at Willenberg's Prague Engineering School, which was established by a decree of Emperor Josef I in 1707. ICT Prague's direct predecessor was the Royal Czech Polytechnical Institute, at which the first university lecture on chemical technology was delivered in the autumn of 1807.

Today, ICT Prague is known for the breadth and depth of its educational and research activities, which extend to almost every branch of chemistry: chemical engineering, food chemistry, biochemistry, petroleum chemistry and refining, water-treatment, power engineering, the biological sciences, biotechnologies, environmental protection and materials science, amongst many others.

ICT Prague is a university--type institution providing education and pursuing scientific research, development and implementation activities. The professional skills and research expertise of its staff are directly passed on to students in its

numerous lecture halls, seminar rooms and well-equipped laboratories.

Graduates from ICT Prague are sought after and valued by a wide range of employers in a wide range of countries. The excellent general education provided by ICT Prague in both the natural sciences and in engineering, together with a strong orientation in informatics and the application of computers, forms an excellent basis for those seeking careers not only within, but also beyond the chemical, petrochemical and food industries.

These claims are evidenced by the famous names that have graduated from ICT Prague and given it an international profile. ICT Prague graduates include Vlado Prelog, who won the 1975 Nobel Prize for Chemistry, and four Presidents of the Czech Academy of Sciences: František Šorm, Otto Wichterle, Rudolf Zahradník, and Jiří Drahoš. Many other graduates have gone on to become leaders in Czech and Slovak industries, as well as in research and development organisations. Today, our graduates are working as professors and scientists at leading American, Australian, German, Swiss and Dutch universities. Others occupy leading positions in world class companies.

I hope that you enjoy reading this prospectus, that it sparks your interest, and that, perhaps, one day soon I will have the pleasure of welcoming you to the opportunities awaiting you here at ICT Prague.

Josef Koubek
Rector

History at the Heart of Europe

Prague - European Historical and Cultural Centre

The million-plus inhabitants of Prague, together with a much larger number of annual foreign visitors, regard it as the most captivating city in the world.

The charm of the Prague basin was discovered by the Celts as early as two thousand years ago. Their craftsmanship and ability to build on the experience of others have left their traces in Prague to the present day.

Several centuries after the Slavs had permanently settled in the region, Prague Castle was founded around the year 900. Rebuilt and expanded many times over the centuries, the castle, silhouetted alongside the spires of St. Vitus Cathedral, has become the best known and most admired symbol of Prague.

However, it was not just for its beauty that Prague became known as the 'heart of Europe'. Its position as a natural crossroads for European trade routes resulted in the rapid growth of skilled crafts and trade centres. The arts and sciences followed so that by the beginning of the 13th century Prague was one of the largest and most architecturally rich cities in Central Europe.

Charles IV made Prague an imperial residence, and founded the first university in Central Europe there in 1348. During his reign, Prague, with its stone bridge, New Town quarter, Old Town Hall, and great many cathedrals and monasteries, became one of the most modern and densely populated cities in the Christian world.

Prague's next great period of development came with Emperor Rudolph II, who moved his imperial seat from Vienna to Prague at the end of the 16th century. Under his rule, Prague became a major centre of European art and science. Rudolph II invited many outstanding artists and scientists to stay at his court, among them Johannes Kepler and Tycho de Brahe, two astronomers with rival theories of the solar system. During Rudolph's reign, moving statues were installed on the Old Town Hall astronomical

clock, a mechanism that continues to attract the attention of visitors and passers-by today. Rudolph II also founded the Prague Castle Picture Gallery, a place where artistic masterpieces have been displayed ever since.

The period of forced re-catholicization that followed the defeat of the Czech Estates at the Battle of White Mountain in 1620 led to Prague being enriched with unique architectural works now valued as works of special cultural significance. The term 'Prague Baroque' embraces many such objects, including the numerous churches, cathedrals and palaces built by G. Santini, G.B. Pieronni and the father and son Dientzenhofers, as well as the sculptures of M.B. Braun and J. Brokoff, and the world famous 'Bambino di Praga', a wax effigy of the Infant Jesus brought from Spain in the mid-16th century.

The 19th century saw the Czech National Revival, which produced huge new building projects, such as the National Theatre, National Museum, Rudolphinum concert hall and Výstaviště exhibition centre.

Meanwhile Prague's Jewish community seemed to develop independently of its history. Europe's oldest surviving synagogue, the Old-New Synagogue in Prague's Old Town, was built in 1270. According to legend, angels brought the foundation stones to Prague from Jerusalem. The Pinkas Synagogue, Maisel Synagogue and High Synagogue were all built during the 16th century. Along with the Old Jewish Cemetery, they rank among the most admired monuments of European Jewish culture.


11.1

Throughout the millennium, Prague's historical core remained practically untouched by the episodes of war that left their traces on other parts of the city. This is why 'the city of one hundred spires' (the real number is close to 500) represents a living textbook of architecture, covering every style from the Romanesque St.George's Basilica to the vast number of Gothic, Renaissance, Baroque and Art Nouveau monuments, right on through to the Cubist 'House of the Black Mother of God'. It is no exaggeration to say that every historical epoch has left its mark on modern Prague. While one cannot escape the influences of the recent past or the rhythms of the present, walking through the city is truly a walk through the centuries.

The architectural beauty of a town and city is always closely connected with its rich cultural life. Prague is a perfect illustration of this truth.

There are more than twenty permanent theatres in Prague at present. The most important of them, the National Theatre (1883), stands as a symbol of the Czech National Revival. Since its birth, all of the most prominent Czech artists have had their work staged there.

The Estates Theatre saw the world premiere of W.A. Mozart's *Don Giovanni* in 1787, the orchestra being conducted by the composer himself.


11.2

11.1 Prague's Old Town Square

11.2 Rudolfinum - the centre of the Prague Spring Music Festival

The Theatre on the Balustrade (Divadlo Na zábradlí) is one of a large number of smaller theatres which have had great historical significance in Prague's cultural life. This is where former Czech President Václav Havel first worked as a stagehand on his way to becoming a prominent playwright.

Classical music lovers are already familiar with the Prague Spring Music Festival. But Prague hosts concerts by world famous artists all year round in a wide variety of concert halls, churches and cathedrals. Excellent jazz can be heard at Reduta, Malostranská beseda and other jazz clubs. And Prague's many rock clubs cater for the tastes of all kinds of rock fans.

Dozens of specialist libraries are open to the public. The most precious collection, of more than 40,000 volumes of Czech books and manuscripts, is housed in the National Literature Memorial located in the 12th century Strahov Monastery.

In addition to the composers mentioned above (Mozart, Smetana, Dvořák), Prague has, at one time or other, been home to many other artists of world renown, including the writers Franz Kafka, Karel Čapek, Josef Škvorecký and Milan Kundera, the poets Rainer Maria Rilke and the 1984 Nobel Prize winner Jaroslav Seifert, the painters Alfons Mucha, František Kupka and Ludvík Marold, the composer Gustav Mahler, and the film director Miloš Forman, whose Oscar-winning *Amadeus* was partly filmed in Prague.

In 1992, Prague's historic centre was added to the list of UNESCO-monitored world heritage sites.

12.1 Dvorak's Hall, Rudolfinum, Prague

The Past and Present of Prague Universities

The Past and the Present of Prague Universities

'Discipulus est prioris posterior dies'
'Today is the pupil of yesterday'
Publius Syrus, 1st century B.C.

The development of European towns in the 12th and 13th centuries was accompanied by the birth of the first universities (Oxford, Bologna, Paris). At the lower levels of education, the sparse network of church schools could no longer accommodate the growing need for general education. Consequently, new types of schools were established, including the so-called 'particular schools', the predecessors of what later became the lower gymnasiums (secondary schools). The system of 'particular schools' came into being in the Czech lands in the 14th century, during the reign of Charles IV, and lasted for several centuries. Despite the rapid growth in schools, the vast majority of people in advanced Europe, which included the Czech lands, were still illiterate as late as the end of the 14th century. According to estimates, only two people in every one thousand could read at that time.

On April 7 1348, Charles IV, Emperor of the Holy Roman Empire and King of Bohemia, founded a university in Prague 'for the embellishment and glory of the Czech Kingdom'. It was the first university to be founded in Central Europe. Charles IV engaged respected scholars from all over Europe to teach at the new university, which consisted of the Faculties of Arts, Medicine, Theology and Law. Students came from all over the Slavonic and German regions of the Holy Roman Empire. In 1409, King Wenceslas IV, the son of Charles IV, changed the ratio of votes by which representatives elected the rector and deans; originally the Czech, Polish, Saxon and Bavarian peoples had one vote each, but from 1409 the Czechs had three votes and the non-Czechs just one. This led to the exodus of German scholars and students to German universities, and the election of Jan Hus, the spiritual leader of the Czech religious reform movement, as rector. Thus, what had been a supranational institution of higher education became a national university, and, as a consequence,

began to lose contact with the wider world. The Faculties of Medicine, Law, and Theology all closed, followed by the Faculty of Arts in 1420. Teaching was reintroduced to the university 20 years later, but remained restricted to the Faculty of Philosophy until the beginning of the 17th century.

In 1609, under the patronage of the Czech Estates an attempt was made to restore all of the faculties of Prague University and raise the level of teaching. In 1622, the Jesuit Academy, founded in 1562 in Prague's Clementinum, tried to annex the faculties of Prague University to its own Faculties of Theology and Philosophy. This gave rise to a dispute between the Jesuit Academy and Prague University, which was only resolved by a 1654 decree of Emperor Ferdinand II. This decree united the Faculties of Philosophy, Theology, Law and Medicine as Charles-Ferdinand University, the name under which the University existed until 1918.

16.1

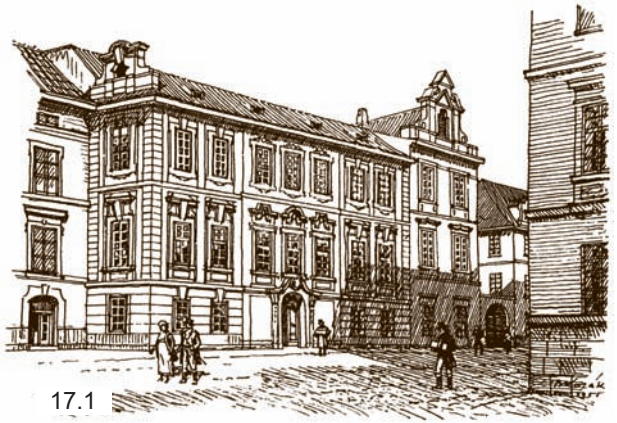
Charles-Ferdinand University underwent extensive reforms after 1782. Under these reforms, the university was opened to non-Catholics, and German replaced Latin as the language of education. Czech efforts at emancipation brought about the equality of Czech and German as teaching languages after 1848, and led to the split of the university into Czech and German sections in 1882. Between 1911 and 1912, Albert Einstein was engaged as Professor of Theoretical Physics at Prague's German University.

After the founding of the independent Czechoslovak Republic in 1918, the Czech section of the university took the name Charles University in 1920. Many prominent

16.1 Alchemist's workshop

scientists taught at the university, among them Professor of Chemistry and 1959 Nobel Prize winner, Jaroslav Heyrovský. The Czech universities were forced to close in 1939 as a result of the German occupation, with the German section remaining as the only functioning university in Prague. However, the German section was abolished after the country's liberation in 1945. The oldest and largest university in the Czech Republic, Charles University today comprises 16 faculties.

The expansion of manufacturing and the beginning of industry in the Czech lands in the second half of the 18th century made it necessary to establish another, more technical, university, Prague Polytechnic. Its predecessor, the Bohemian Estates Engineering School had been founded in Prague as early as 1707. Under the leadership of Franz Joseph Gerstner, who used Paris Polytechnic as a model, the Bohemian Estates Engineering School was transformed into the Royal Czech Polytechnical Institute, Prague Polytechnic, in 1806. The school originally comprised the departments of mathematics and chemistry.

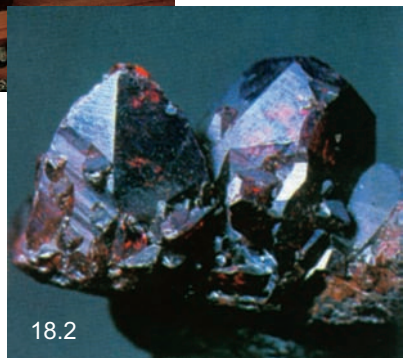


17.1

Growing demand from the glass and iron industries for knowledge about raw materials led to the foundation of the department of mineralogy. This department also helped to prepare the geological experts needed for the extensive road and railway building that took place from the mid-19th century onwards. The first professor of mineralogy at Prague Polytechnic, František Xaver Maxmilián Zippe, established a mineralogical collection at Prague Polytechnic in the first half of the 19th century. This collection was continuously expanded by several generations of teachers at the subsequent Institute of Chemical Technology. Apart from the collection

17.1 Former St. Wenceslas Seminary

18.1



18.2

housed at the National Museum, it is the second most precious collection of minerals in the Czech Republic.

In 1863, Prague Polytechnic was transformed into an independent university headed by a rector, and, in 1869, was divided into two independent schools, one Czech and one German. The Czech school moved to a new building in Charles Square in 1874, and, in 1879, was renamed the Czech School of Technology.

In 1920, the school's name changed to the Czech Technical University. Its best-known professor was František Běhounek, who studied for his doctoral degree under the supervision of Marie Curie-Sklodowska and took part in the polar expedition led by Umberto Nobile. Vlado Prelog, the winner of the 1975 Nobel Prize for Chemistry, graduated from the School of Chemical Technology, then part of the Czech Technical University, in 1928.

In 1952, two sections separated from the Czech Technical University to form two independent institutes of higher education; the Institute of Chemical Technology and the School of Agriculture, now the Czech Agricultural University. Another section, the School of Commerce, was abolished in 1952 and the Prague School of Economics (now University of Economics, Prague) established in its place a year later.

The Academy of Fine Arts was founded in Prague in 1800 to educate and train painters, sculptors, architects and artwork restorers. In 1880, the Academy was transformed into a university headed by an elected rector.

18.1,2 Unique mineralogical collections at the Institute of Chemical Technology, Prague

The school provided education, and later also positions, to a number of notable Czech artists.

From 1885, applied arts (printing, sculpture, design, and the treatment of artistic materials) were taught at the School of Applied Arts, which, in 1946, became the University of Applied Arts.

The Academy of Performing Arts was founded in Prague in 1945 to provide instruction in the dramatic arts, music, and film.

The Police Academy, founded in 1992, completes the list of Prague institutes of higher education.

At present, about 60,000 students study at Prague's nine universities. In terms of the number of students, the Institute of Chemical Technology ranks among Prague's medium-size institutions of higher education.

Prague's history and charm have always attracted those longing for spiritual enlightenment. The 1989 'velvet revolution' turned Prague into a city echoing the Paris of the 1920's, and Prague became one of the most attractive cities for university studies. Today, students of most fields who decide to study in Prague find an excellent standard of university education, as well as open access to information on computer networks and to sources both old and new in the many libraries. They become part of the stimulating environment of Prague's diverse student community and have the opportunity to fully enjoy Prague's immensely rich cultural life.

19.1 Malostranska Tower, Charles Bridge

Teaching of Chemistry Prior to the Foundation of Prague Polytechnic

After Prague University was founded by Charles IV in 1348, education in the natural sciences at the Faculty of Arts (later the Faculty of Philosophy) mainly focused on mathematics and astronomy, although a basic knowledge of alchemy was also provided.

Directly applicable empirical methods began to diverge from alchemy in the 15th and 16th centuries. In the Czech lands in the first half of the 16th century, Georgius Agricola summarized his experience in mining and metallurgy in his treatise *De re metallica libri*, which was highly critical of the alchemists.

However, there were still a number of alchemists engaged at the court of Rudolph II as late as the turn of the 17th century. And alchemy certainly deserves our respect. By just 1200, alchemists had catalogued the following: a number of elements (sulphur, carbon, copper, iron, tin, mercury, silver, gold and perhaps others); the basic acids *spiritus vitrioli* (sulphuric acid), *spiritus salis* (hydrochloric acid), *aqua fortis* (nitric acid), and *aqua regia* (nitro-hydrochloric acid), together with some of their salts (alum, ammonium chloride), and a variety of other substances (e.g. borax). They were also familiar with distillation, sublimation, crystallization, filtration and other chemical processes.

During the Jesuit hegemony, the teaching of natural sciences at Charles-Ferdinand University was suppressed. The only exception related to Jan Marek Marci, Professor of Medicine and personal doctor to the Emperors Ferdinand III and Leopold I, who was purportedly responsible for several notable achievements in physics (closely linked to chemistry), such as the definition of laws relating to elastic balls, light dispersion, and the observation of colours in thin layers. His work was known to Dutch mathematician and physicist Christiaan Huyghens.

It was only at the end of the 18th century, during the Age of Enlightenment and after the university was transferred to the jurisdiction of the state, that the need to educate doctors led to emphasis being

placed on the natural sciences. Thus, chemistry became an important field of study at Prague University during the 19th century.

Teaching of Chemistry at Prague Polytechnic

The founding charter of Prague Polytechnic, officially named the Royal Czech Polytechnical Institute, was signed by Emperor Francis II at the beginning of 1803. Courses in its two departments, mathematics and chemistry, began on November 10 1806. The modern day Institute of Chemical Technology, Prague descends directly from the chemistry department of Prague Polytechnic.

The chemistry department provided instruction in general and practical chemistry with particular focus on the major Czech industries of the time (glass and iron), on chemistry applied to the textile industry, and on the processes of bleaching and dyeing. The first professor of chemistry at Prague Polytechnic was Karl Augustin Neumann, an experienced industrial chemist. During his tenure (1807-1816), chemistry courses lasted just one year. Under Professor Josef Steinmann (1817-1833), brewing was added as a field of study and all courses were extended to two years. The teaching of technical chemistry at Prague Polytechnic reached a high standard under Professor Karl Napoleon Balling (1833-1868), who added sugar manufacture and analytical chemistry to the fields of study.


21.1


21.2

Parallel courses in chemistry in Czech and German began in the academic year of 1864-65. The first professor to teach general and specialized chemistry in Czech was Jan Staněk. Under his professorship, the study of chemistry was extended to four years.


21.3

21.1 First Professor of chemistry Karl Augustin Neumann
21.2 Professor Karl Napoleon Balling
21.3 Professor Jan Staněk


22.1

In 1860, the first Czech textbook *Introduction to Chemistry* (*Základové chemie čili lučby*) was published. Its author, Vojtěch Šafařík, the son of Pavel Josef Šafařík, was a prominent figure in the Czech National Revival. After the division of Prague Polytechnic into independent German and Czech schools in 1869, he became Professor of General and Analytical Chemistry at the Czech school.

Professor Šafařík was one of the founders of the Czech chemical sciences, as well as a contributor to the creation of Czech chemical nomenclature. He resisted the attempts of Jan Svatopluk Presl and Josef Jungmann to define Czech names for all of the chemical elements, and removed many of the, often quite amusing, names they had artificially derived from Czech words. While he kept some of their newly formed words (e.g. those for hydrogen, oxygen and nitrogen), he applied the common Greek-Latin names for the majority of the elements. His chemical nomenclature continues to be in use today. Taking advantage of the richness of the Czech language, Professor Šafařík introduced suffixes that indicate the oxidation states from II to VIII so that anyone who knows the scientific meaning of these suffixes is able, when reading the name


22.2

22.1 Professor Vojtěch Šafařík
22.2 Seat of Prague Polytechnic's Chemistry Department and later School of Chemical Technology in Trojanova Street

of the compound, to write its formula and vice versa. These suffixes have been used ever since and are still highly appreciated.

The status of chemistry as a field of study was significantly improved by Bohuslav Raýman who, after graduating from Prague Polytechnic, worked in the laboratories of the prominent chemists Friedrich August Kekulé, Adolf Wurtz and Charles Friedel. As Professor of Inorganic Chemistry at Prague Polytechnic, he helped the school gain the right to bestow academic degrees. As a result, the first doctorates in chemistry were awarded in 1901.


23.1

By the turn of the 20th century, Prague Polytechnic was providing courses in inorganic, organic, analytical, and physical chemistry, all of which included extensive laboratory


23.2

training. Instruction was also available for different specializations in technical chemistry, combined with laboratory training in areas such as mineral analysis, the technical analysis of gases, and analysis for the needs of sugar manufacture.

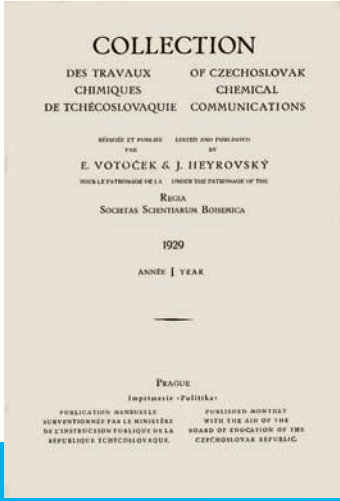
The extraordinary growth in chemistry education and in scientific research at Prague Polytechnic in the first third of the 20th century is linked with the name of Professor Emil Votoček, who, in 1907, was granted a professorship in experimental inorganic and organic chemistry.

23.1 Emil Votoček, Associate Professor of General Chemistry
23.2 Professor Votoček's laboratory

Teaching of Chemistry at the School of Chemical Technology

In 1920, the reorganization of Prague Polytechnic resulted in its chemistry department being transformed into the Prague School of Chemical Technology, one of the seven faculties of the Czech Technical University.

Professor Votoček was a leading figure at the newly established school. His scientific activity, which embraced organic, inorganic and analytical chemistry, earned Czech chemistry world renown. In 1929, together with Jaroslav Heyrovský, Professor of Chemistry at Charles University and the winner of the 1959 Nobel Prize for Chemistry, Votoček founded the scientific journal *Collection of Czechoslovak Chemical Communications*. The journal has been publishing English translations of original works by Czech and Slovak chemists to the present day.


COLLECTION
DES TRAVAUX CHIMIQUES DE TCHÉCOSLOVAQUIE
OF CZECHOSLOVAK CHEMICAL COMMUNICATIONS
E. VOTOČEK & J. HEYROVSKÝ
REGIA SOCIETAS SCIENTIARUM BOHEMICA
1929
ANNÉE I YEAR
PRAGUE

24.1 Front cover of the first issue of Collection of Czechoslovak Chemical Communications

Professor Votoček was an excellent teacher. His inorganic and organic chemistry textbooks were unrivalled at the time and helped educate several generations of chemists. The changes he made in Czech chemical nomenclature are still in use today.

Professor Votoček's activity was not restricted to chemistry. Supported by extensive travelling, his interest in lexicography and phraseology gave rise to numerous professional translations and also to several dictionaries, including a Czech-French terminological and phraseological dictionary for chemistry, physics and related sciences (1924), and a six-language Czech-German-English-Italian-Latin-French chemical dictionary (1952). Professor Votoček could also play several musical instruments and created an extensive dictionary of foreign musical expressions and phrases, comprising 12,000 entries. He wrote approximately 70 noted musical works, including songs and compositions for the piano and small musical ensembles.

24.1

25.1

Emil Votoček was the author of more than 300 scientific articles which won him considerable recognition abroad. He received honorary doctorates from several universities, among them the Sorbonne in Paris.

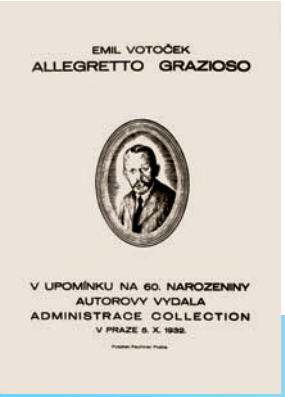
During Emil Votoček's professorship, a number of notable chemists graduated from the Prague School of Chemical Technology. The best known is probably Professor Otto Wichterle, who invented contact lenses. Another, Professor Otakar Quadrat studied chemical influences on the properties of steel and cast iron during his professorship at the University of Nancy, and became a Knight and Officer of the French Honorary Legion.

25.3

25.4

Professor Rudolf Lukeš took over the Department of General and Experimental Chemistry from Professor Votoček after his retirement in 1938. Students who attended his lectures from the 1930s to 1960 describe his teaching style in superlatives. Using a systematic classification scheme that is still in use today, he was able to make the large and seemingly confusing set of organic compounds comprehensible.

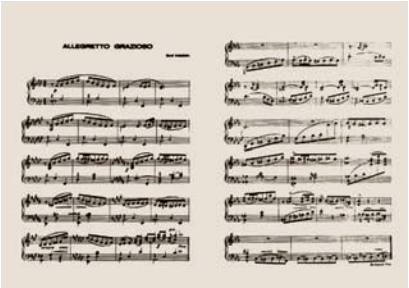
Meanwhile, in 1949, Professor Otto Wichterle founded the Institute of Plastics at the School



EMIL VOTOČEK
ALLEGRETTO GRAZIOSO

V UPOMÍNKU NA 60. NAROZENINY
AUTOROVY VYDALA
ADMINISTRACE COLLECTION
V PRAZE 5. X. 1932.

25.2



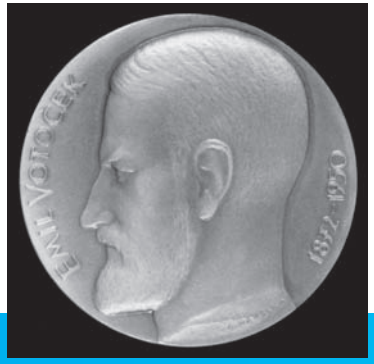
25.5

25.1 Professor Emil Votoček
25.2 Score of a composition by Professor Votoček
25.3 Professor Otakar Quadrat
25.4 Professor Rudolf Lukeš
25.5 Professor Otto Wichterle

26.1

of Chemical Technology. In 1951 he began research into hydrophilic gels that led to the development of the world's first contact lenses.

Vlado Prelog also graduated from the Prague School of Chemical Technology, in 1928, before going on to obtain a doctorate there. As a professor at the Swiss Federal Institute of Technology (ETH) in Zurich, he was awarded the Nobel Prize for Chemistry in 1975 for his contribution to the stereochemistry of organic molecules and their reactions.



26.2

The tradition of Professor Votoček lives on at the modern Institute of Chemical Technology. The highest student award for outstanding work in postgraduate courses, the Votoček Scholarship, is bestowed in his name. And, the Votoček Medal is conferred on exceptional scientists in recognition of their contribution to chemistry and chemical technology.

26.3

On June 21 1925, the foundation stone of the first building of the campus of the Czech Technical University was laid in Dejvice in the presence of President T. G. Masaryk. The campus was designed to be integrated with the architecture of this modern and attractive residential area. This first building was designated for the School of Chemical Technology and continues to serve in this capacity. Courses were taught there from 1933 onwards. Although the construction

26.1 Vlado Prelog, graduate of Prague School of Chemical Technology and winner of the 1975 Nobel Prize in Chemistry

26.2 The Emil Votoček Medal, awarded by ICT Prague for exceptional merit in the development of chemistry or in cooperation with ICT Prague

26.3 The foundation stone of the School of Chemical Technology in Prague-Dejvice

of additional buildings was hindered by financial problems, 1937 saw the completion of the second building, which is currently shared by the Institute of Chemical Technology and the Czech Technical University. This has been the case since 1952, when the School of Chemical Technology was separated from the Czech Technical University and began its independent existence as the Institute of Chemical Technology, Prague. Since the beginning of its independent existence, over 15,000 chemical engineers have graduated from ICT Prague along with hundreds of holders of higher academic and scientific titles.

At that time it was divided into three Faculties: Faculty of Inorganic Technology, Faculty of Organic Technology, and Faculty of Food Technology.

The Faculty of the Chemical Technology of Fuels, added in 1953, was renamed as the Faculty of the Chemical Technology of Fuels and Water in 1959. The Faculty of Automation and Economics was established in 1960.

The newly-established Institute of Chemical Technology placed greater emphasis on the role of mathematical, physical and physicochemical fundamentals in its educational programmes.

At the close of the 1960s, the Faculty of Organic Technology and Faculty of Inorganic Technology merged into the current Faculty of Chemical Technology. At the same time changes were also made to the names of some of the other faculties. The Faculty of Food Chemistry was renamed the Faculty of Food and Biochemical Technology, while the Faculty of Automation and Economics became the Faculty of Chemical Engineering. The Faculty of the Chemical Technology of Fuels and Water changed its curriculum in 1991 and was, consequently, renamed the Faculty of Environmental Technology.

27.1 The completed School of Chemical Technology in Prague-Dejvice (1932)
27.2 The inorganic chemistry lab at the School of Chemical Technology in Prague-Dejvice

Campus of the Institute of Chemical Technology, Prague (ICT Prague)

The Institute of Chemical Technology, Prague

The Institute of Chemical Technology, Prague

The Institute of Chemical Technology, Prague (ICT Prague) is the largest institution of higher education devoted to the teaching of chemical technology in Central Europe. It is a university-type public institution, which has the right of self-government and enjoys academic freedoms as defined by *Law on Universities and the Statutes of the Institute of Chemical Technology, Prague*. The largest part of the institute's funding comes from the state budget, with the remainder coming from domestic and foreign grants, as well as from cooperation with industrial companies and other organizations.

ICT Prague is headed by a rector, who is appointed by the President of the Czech Republic. The rector coordinates the educational, scientific and administrative activity of the individual Faculties.

ICT Prague consists of four faculties:

- Faculty of Chemical Technology
- Faculty of Environmental Technology
- Faculty of Food and Biochemical Technology
- Faculty of Chemical Engineering

Each faculty is headed by a dean.

Currently, ICT Prague comprises about 750 staff, including about 70 professors, 120 associate professors, and 240 assistant professors and assistants.

ICT is based in Prague 6 - Dejvice, in three buildings which are located close to the Dejvická metro station. The buildings of the Czech Technical University – Faculties of Mechanical Engineering, Electrical Engineering, Civil Engineering and Architecture – are all situated nearby.

Students whose permanent residence is outside Prague may apply for accommodation in the Jižní Město-Chodov Halls of Residence on the southern outskirts of Prague.

31.1

31.1 Founding Charter of the Institute of Chemical Technology, Prague (ICT Prague) with the seal

System of Studies

Based on the decision of the Czech Government Accreditation Commission, as of academic year 2004-2005, all ICT Prague faculties are accredited to provide:

- **Three-year B.Sc. programmes leading to the award of the academic title 'Bachelor', abbr. Bc.**
- **Two-year M.Sc. programmes leading to the award of the academic title 'Engineer', abbr. Ing.**
- **Four-year Ph.D. programmes leading to the award of the academic and scientific title 'Doctor of Philosophy', abbr. Ph.D.**
- **ICT Prague provides all graduates with a Diploma Supplement (in Czech and English) free of charge.**

The ICT Prague faculties also provide lifelong education programmes in the form of various long- and short-term courses that lead to the award of a certificate. For example, for a number of years, the Faculty of Food and Biochemical Technology has been providing four-semester programmes for seniors under the 'Third-Age University' scheme. Excursions to various food plants are organized within these programmes.

The academic year consists of two terms (semesters). The winter semester, which starts the academic year, begins in mid-September, while the summer semester begins in mid-February.

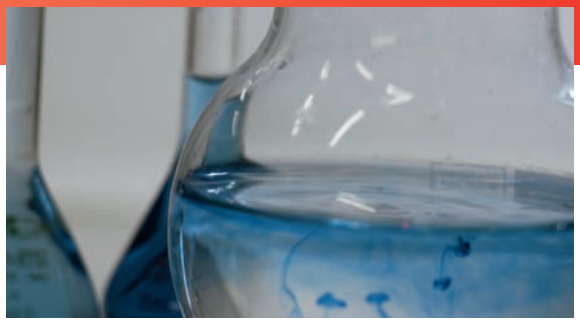
Apart from regular (full-time) studies, a combined form of studies is also available for those studying while employed. This form of study consists of mandatory on-campus courses supplemented with consultations and individual work.

B.Sc. Programmes in Czech

The B.Sc. programmes taught at ICT Prague are listed in the table below. Core courses are followed by those focused on a career-oriented field.

These first degree programmes are completed by a state examination and the defence of a bachelor thesis. Graduates are awarded the

title 'Bachelor' (equivalent to B.Sc.). The dean of each faculty may arrange individual study plans for students on request, allowing them to complete their first degree programmes while being employed.



Faculty of Chemical Technology

Study programme	Study sub-programme
Applied Chemistry and Materials	Chemistry and Chemical Technologies
	Chemistry and Technology of Materials
	Chemistry and Applied Ecology
	Informatics and Chemistry
	Chemistry of Materials for the Automotive Industry
Drug Synthesis and Production	Drug Synthesis and Production
Conservation-Restoration of Cultural Heritage Objects – Works of Arts and Crafts	Technology of Conservation-Restoration
	Conservation-Restoration of Metallic Works of Arts and Crafts
	Conservation-Restoration of Glass and Ceramic Works of Arts and Crafts
	Conservation-Restoration of Textile Works of Arts and Crafts
Biomaterials for Medical Purposes	Biomaterials for Medical Purposes

Faculty of Environmental Technology

Study programme	Study sub-programme
Environmental Technology	Environmental Chemistry and Technology
	Fuel and Environmental Chemistry and Technology
	Alternative Energies and the Environment
	Environmental Chemistry and Toxicology
	Environmental Analytical Chemistry

Faculty of Food and Biochemical Technology

Study programme	Study sub-programme
Food and Biochemical Technology	Food Technology
	Food Chemistry and Analysis
	Biochemistry and Biotechnology
Drug Synthesis and Production	Drug Biotechnology

Faculty of Chemical Engineering

Study programme	Study sub-programme
Engineering and Management	Process Engineering, Informatics and Management
	Technical, Physical and Analytical Chemistry
Engineering Informatics	Engineering Informatics
Chemistry	Chemistry*
Nano- and Micro-technology in Chemical Engineering	Nano- and Micro-technology in Chemical Engineering
Drug Synthesis and Production	Drug Analysis

* Graduates are awarded the Eurobachelor degree

Graduates' Professional Career Prospects

The aim of B.Sc. programmes is to prepare experts for careers in the manufacturing plants of the chemical and food industries, in inspection and control bodies, in commerce and in public administration.

Courses for Future Secondary School Chemistry Teachers

ICT Prague

Study programme
Pedagogic Specialization
Study sub-programme
Teaching of Technical Subjects

Additional courses for future secondary school chemistry teachers are provided in parallel to other undergraduate programmes, with a final thesis defended in the eighth semester. Postgraduate courses are open to graduates from ICT Prague and other chemistry-related universities (faculties) on the payment of a tuition fee.

The educational programme is focused on psychology, pedagogy, school management, didactics and practical teacher training. It is completed by the defence of a final thesis and by an examination before an examination committee.

The high quality of study programmes at ICT Prague led to it becoming a member of the International Society for Engineering Education (IGIP), which means that those who complete these specialized teacher training courses may apply for teaching positions throughout Europe.

M.Sc. Programmes in Czech

M.Sc. programmes are two-year specialized programmes that extend the three-year B.Sc. programmes. ICT Prague provides M.Sc. courses in study programmes that are subdivided into individual fields of study. In the final part of their studies, students select a field of specialization that forms the basis for their diploma thesis. All students can modify their plans of studies by choosing optional courses from within their own field or from other fields taught at ICT Prague, or even at other universities.

Faculty of Chemical Technology

Study programme	Study sub-programme
Chemistry and Chemical Technologies	Fundamental and Special Inorganic Technologies
	Technology for Organic Compounds and Chemical Specialties
	Applied Informatics in Chemistry
Chemistry of Materials and Materials Engineering	Inorganic Non-metallic Materials
	Metallic Materials
	Polymeric Materials
	Materials for Electronics
	Nanomaterials
Drug Synthesis and Production	Drug Synthesis
	Drug Production
Conservation-Restoration of Cultural Heritage Objects	Conservation and Restoration Technologies
Inorganic, Organic and Macromolecular Chemistry	Inorganic Chemistry
	Organic Chemistry
	Macromolecular Chemistry

Faculty of Environmental Technology

Study programme	Study sub-programme
Environmental Technology	Water Technology
	Environmental Chemistry and Technology
	Fuel and Environmental Chemistry and Technology
	Environmental Analytical Chemistry

Faculty of Food and Biochemical Technology

Study programme	Study sub-programme
Food Technology	Carbohydrate Chemistry and Technology
	Dairy and Fat Technology
	Food Preservation and Meat Technology
Food Chemistry and Analysis	Food Quality and Safety
	Chemistry of Natural Compounds
Biochemistry and Biotechnology	General and Applied Biochemistry
	Microbiology
	Biotechnology
Drug Synthesis and Production	Drug Biotechnology
Clinical Bioanalytics	Laboratory Methods and Preparation of Medical Formulations

Faculty of Chemical Engineering

Study programme	Study sub-programme
Technical Physical and Analytical Chemistry	Analytical Chemistry and Quality Engineering
	Physical Chemistry
	Molecular Engineering
Economics and management of Chemical and Food Companies	Economics and Management of Chemical and Food Companies
Process Engineering and Informatics	Chemical Engineering, Bioengineering and Mathematical Modelling of Processes
	Engineering Informatics and Process Control
Applied Engineering Informatics	Applied Engineering Informatics
Drug Synthesis and Production	Drug Analysis

The aim of courses within a given field of study, or given field of specialization, is to develop a general engineering approach so that, based on both their deep knowledge of the principles of specific technological processes and their experimental experience, students are able to deal with the problems they later encounter in their chosen career. Graduates who have completed these courses are well-equipped for pursing careers in the relevant fields, although their strong educational basis also means that they are easily able to adapt to work in other fields and pursue a wide range of professional activities.

In educating their students, most departments cooperate with leading experts in their field. This includes organising foreign guests whose lectures enhance students' knowledge of foreign languages. 'On-the-job training' forms a part of every course. In addition, students are offered a large variety of scholarships abroad, in nearly every advanced country.

M.Sc. programmes at ICT Prague are completed by a final state examination comprising the defence of a diploma thesis. Graduates are awarded the academic title 'Engineer' (equivalent to M.Sc.). Diplomas are presented to graduates at a graduation ceremony.

The dean of each faculty may arrange individual study plans for students on request, allowing them to complete their M.Sc. degree courses while being employed.

Graduates' Professional Career Prospects

Over the long term, the demand for graduates from all areas of study at ICT Prague exceeds the number of graduates each year. Surveys show that demand for experts with a university education can be expected to further increase in the future. This particularly applies to the chemical industry, the continuing modernization of which is increasing the demand for qualified chemists.

ICT Prague graduates can work as technologists, scientific research workers, managers and technicians in a wide range of fields, not just those related to the chemical and food industries. With their knowledge of chemical and technical disciplines, their grasp of the fundamentals of economics and their excellent command of IT equipment, ICT Prague graduates are able to develop professional careers even outside their field of specialization.

ICT Prague provides students with information on available jobs. The individual

faculties organize meetings between students and the representatives of companies, research institutes, and other potential employers. Job offers for ICT Prague graduates are also communicated via the IAESTE student organizations.

Due to the high standards ensuing from the high demands placed on students during their studies, ICT Prague graduates are highly regarded, both in the Czech Republic and abroad.

Study Programmes in English

From the academic year 2011/2012, ICT Prague offers the new study programme 'Life Sciences', taught in English to foreign students. This programme covers both the B.Sc. and M.Sc. sub-programmes specified in the following table:

Students interested in English study programmes can obtain more detailed information on the ICT Prague website http://www.ict-prague.eu or upon request from the Department of International Relations (see page 119).

Type of study	Study programme	Study sub-programme
Bachelor	Life Sciences	Environmental Chemistry and Technology
graduates – B.Sc. degree		Food and Biochemical Technology
		Chemistry and Materials
		Chemistry, Engineering and Technology
Master	Life Sciences	Applied Chemistry
graduates – M.Sc. degree		Biochemistry and Biotechnology
		Engineering and Technology
		Environmental Chemistry and Technology
		Food Processing, Quality and Safety
		Chemistry and Materials

Ph.D. Programmes

Ph.D. programmes are based on individual study plans comprising lectures, seminars, domestic and foreign study visits, and, of course, examinations. All activities are focused on the main aim of study, which involves the systematic solution of a specific scientific problem in a given field and results in the completion and defence of a doctoral thesis.

Ph.D. studies may take place on-campus or off-campus, or may involve a combination of both forms. Students of on-campus programmes are granted allowances for their living costs and a basic scholarship for the standard length of studies (i.e. 48 months). Based on the results of their studies and work, students may win other types of scholarship.

Postgraduate students work under the guidance of their supervisors according to an individual study plan approved by the field council of the given programme of studies. The ICT Prague faculties provide Ph.D. courses in the following programmes and fields of study:

Faculty of Chemical Technology

Study programme	Study sub-programme
Chemistry	Inorganic Chemistry
	Organic Chemistry
	Macromolecular Chemistry
Chemistry and Chemical Technologies	Inorganic Technology
	Organic Technology
Chemistry and Technology of Materials	Technology of Macromolecular Compounds
	Metallurgy
	Chemistry and Technology of Inorganic Materials
	Materials Science and Engineering

Faculty of Environmental Technology

Study programme	Study sub-programme
Environmental Chemistry and Technology	Environmental Chemistry and Technology
Fuel and Environmental Chemistry and Technology	Chemical Treatment of Fuels and their Use in Power Engineering
	Power Engineering in Chemical Technology Processes

Faculty of Food and Biochemical Technology

Study programme	Study sub-programme
Chemistry	Organic Chemistry
	Biochemistry
Microbiology	Microbiology
Biochemistry and Biotechnology	Biotechnology
Food Chemistry and Technology	Food Chemistry and Analysis
	Food Technology

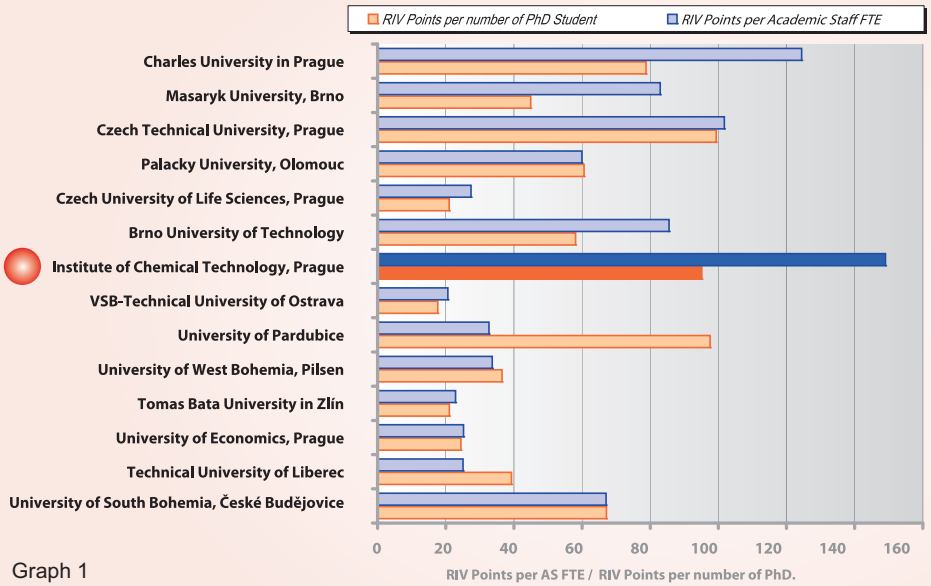
Faculty of Chemical Engineering

Study programme	Study sub-programme
Chemistry	Analytical Chemistry
	Physical Chemistry
Chemical and Process Engineering	Chemical Engineering
	Technical Cybernetics
	Company Management and Economics
Applied Mathematics	Applied Mathematics

Scientific Activity

ICT Prague is a large science and research centre focused on chemical technology, biochemistry, the food industry, environmental protection and a wide variety of other related interdisciplinary fields. The following factors contribute to the high standard of science and research at ICT Prague:

- The significant position of the chemical industry within the Czech industrial sector, with its constant need for the research and development of new products and new production technologies.
- The need to protect the quality of the living environment.
- The cooperation, but also competition, that exists in Prague between the five large chemical, biochemical, and microbiological institutes of the Academy of Sciences of the Czech Republic, all of which rank among the highest-rated institutes of the Academy.



Graph 1

The Graph 1 documents the leading research position of ICT Prague based on the evaluation of the research outcome of Czech universities collected by the R&D Government Office of the Czech Republic. These so called RIV (Information Register of R&D results) points serve as a basic criterion for the distribution of disposable financial means among Czech universities and research institutions. Therefore substantial part of the financial support of ICT Prague is generated by its R&D activities.

The scientific and research activities of ICT Prague can be divided into several categories:

Basic research is aimed at enhancing scientific knowledge without any immediate or foreseeable application. Its results are published in the scientific literature and presented at scientific conferences.

Applied research encompasses research into processes and the development of technologies with a view to their potential application in production and other areas.

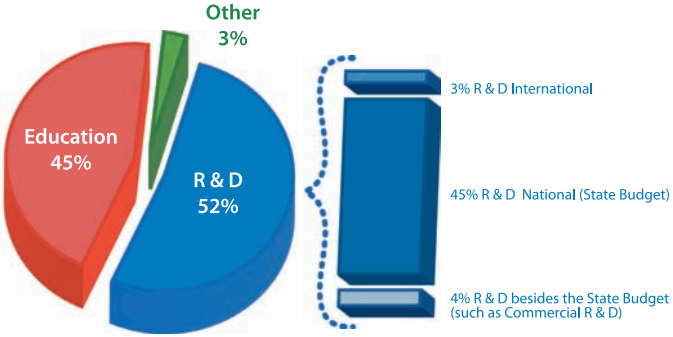
Development advances the results of basic and applied research while focusing on the application of technologies that lead to new or upgraded products and processes.

Innovation involves the commercial application of new or upgraded products and processes.

ICT Prague gives priority to scientific research in the following fields:

- **Biochemistry and biotechnology.**
- **New special chemicals.**
- **Microbiology.**
- **State-of-the-art technologies.**
- **Environmental protection.**
- **Process engineering.**
- **Food industry.**
- **Nanotechnologies.**
- **Molecular biology.**
- **Biomedicinal chemistry.**
- **New materials.**
- **Food analysis.**
- **Information technologies.**
- **Management and economy.**

These research orientations fully accord with research priorities identified by the European Union. Consequently, ICT Prague receives considerable funding in the form of both foreign and domestic grants for research into these important fields.



ICT Prague budget

Postgraduate students and those in the upper years of a master's programme are actively involved in the scientific and research activities pursued by ICT Prague. They have the opportunity to present the results of their work at students' scientific conferences.

To support students involved in research projects, ICT Prague has an internal grant system, which is funded partly from within its own budget and partly by the Ministry of Education. Besides creating a broader scope for valuable scientific activity, the main aim of these grants is to support cooperation between individual departments and to involve other undergraduate and postgraduate students in the implementation of scientific projects.

Annually, several grants are awarded for research into chemistry teaching; for example, to monitor the relationship between entrance exam results and the study of mathematics in the first year of studies, or to study the connection between students' approach to work with computer equipment and their previous experience of it.

This scientific research activity results in extensive publishing activity. Each year, ICT Prague staff publish several hundred original scientific papers and reviews in leading Czech and foreign periodicals, as well as dozens of scientific monographs. In addition, they present several hundred lectures, reports, and posters at both national and international scientific conferences.

Furthermore, many domestic and international institutions request the expertise of ICT Prague staff. Teams of ICT Prague staff and students are currently involved in eight high-profile scientific projects that cover virtually all fields of technical chemistry.

ICT Prague receives substantial funding from industrial contracts, in which its staff apply the findings of basic and applied research to specific chemistry-related development and production problems in industry and other areas.

Students in all forms of study participate in this activity, deriving major advantages from being directly involved in industrial development and the practical application of advanced chemical technology. These benefits aside, cooperation with industry also enables students to earn valuable extra income.

Every year research at ICT Prague results in the implementation of a large number of technical projects. Annually, ICT Prague staff submit inventions, have patents approved and are granted licence agreements.

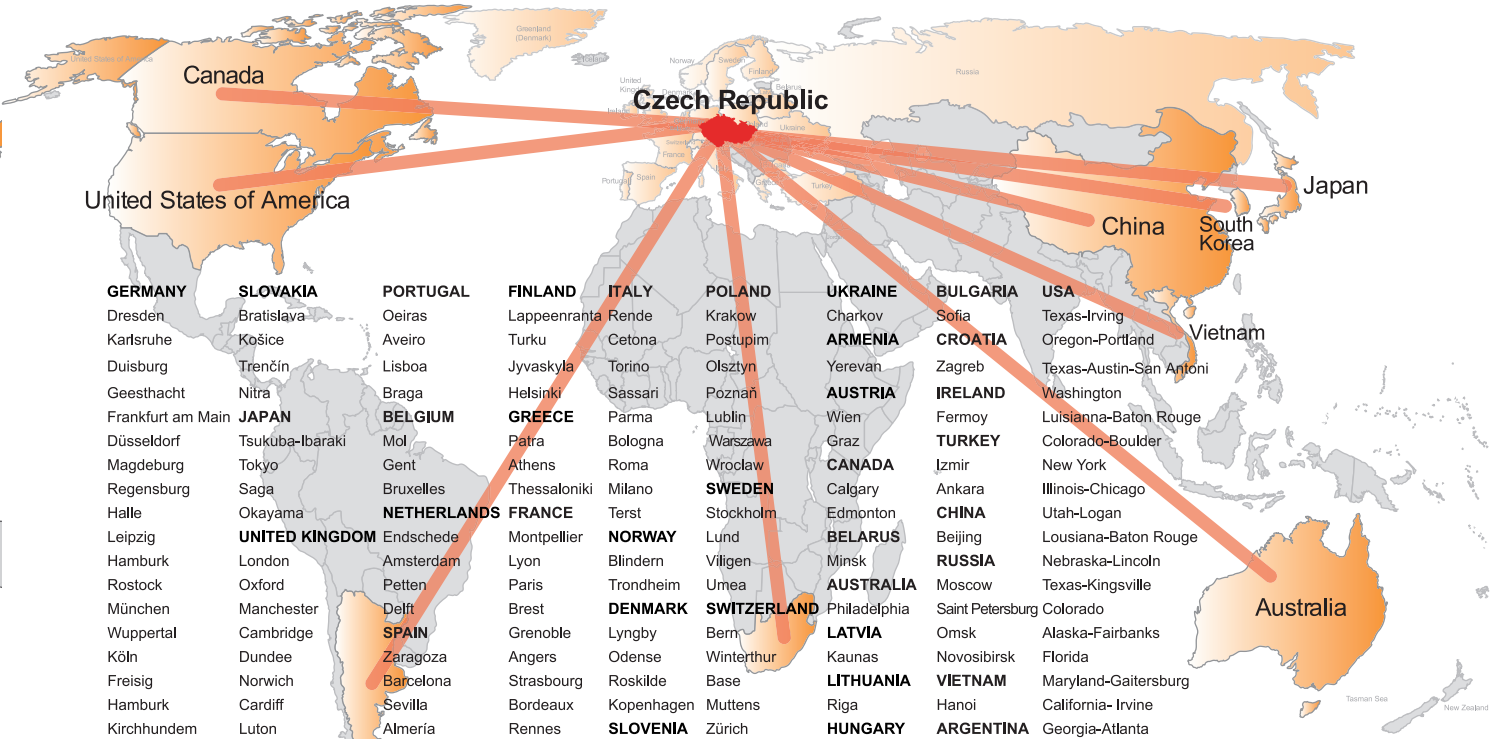
International Cooperation

ICT Prague views international contacts as a very significant part of its teaching and scientific activity.

It cooperates with over 50 universities and institutions, most of which are in Europe, but others of which are in the USA, Canada, Japan and other countries. ICT Prague staff maintain their own contacts with foreign researchers. Together with their foreign colleagues, they seek grants both within European Union programmes (e.g. European Framework Programmes, ESF, LIFE, TEMPUS, COST, COPERNICUS, EUREKA, LLP/ERASMUS) programmes supported by other international grant agencies (NATO, NIH, Fullbright, Wellcome trust, CERN) and numerous bilateral programmes worldwide.

International contacts allow ICT Prague students to attend short- or long-term study programmes at partner universities or other institutions, during which they can work on their diploma theses or dissertations. These ties also allow for teacher exchange, thereby enabling ICT Prague staff to familiarise themselves with teaching methods and scientific work at partner institutions. In addition, visits by foreign lecturers and scientists give ICT Prague students the opportunity to listen to lectures in a foreign language.


Finland
Russia
Norway
Sweden
Estonia
Latvia
Denmark
Lithuania
Belarus
Ireland
United Kingdom
Netherlands
Poland
Ukraine
Belgium
Germany
Prague
Czech Republic
Slovakia
Moldova
France
Switzerland
Austria
Hungary
Romania
Slovenia
Bosnia & Herzegovina
Croatia
Serbia & Montenegro
Bulgaria
Italy
Turkey
Portugal
Macedonia
Albania
Spain
Greece



GERMANY
Dresden
Karlsruhe
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Geesthacht
Frankfurt am Main
Düsseldorf
Magdeburg
Regensburg
Halle
Leipzig
Hamburk
Rostock
München
Wuppertal
Köln
Freisig
Hamburk
Kirchhundem
Norimberk
Berlin
Bayreuth
Stutgart
Karlsruhe

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Okayama

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Tucumán

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Oregon-Portland
Texas-Austin-San Antoni
Washington
Luisianna-Baton Rouge
Colorado-Boulder
New York
Illinois-Chicago
Utah-Logan
Lousiana-Baton Rouge
Nebraska-Lincoln
Texas-Kingsville
Colorado
Alaska-Fairbanks
Florida
Maryland-Gaitersburg
California- Irvine
Georgia-Atlanta

SOUTH AFRICA
Vanderbijlpark

Faculty of Chemical Technology

Departments

- Department of Inorganic Chemistry
- Department of Inorganic Technology
- Department of Metals and Corrosion Engineering
- Department of Glass and Ceramics
- Department of Solid State Chemistry
- Department of Organic Chemistry
- Department of Organic Technology
- Department of Polymers
- Department of Solid State Engineering
- Laboratory of Inorganic Materials
- Department of Chemical Technology of Conservation-Restoration of Cultural Heritage Objects

Faculty of Chemical Technology

Faculty of Chemical Technology

The Faculty of Chemical Technology came into being in 1969 as a result of the merger of the Faculty of Inorganic Technology and the Faculty of Organic Technology. In 1952, these faculties, together with the Faculty of Food Technology, had been founding members of the independent Institute of Chemical Technology. However, university-level teaching of the fields in which the Faculty of Chemical Technology has won both its traditional and current scientific prestige can be traced back as far as 1807, when applied chemistry first began to be taught in the Czech lands at the Royal Czech Polytechnic School. Courses in applied chemistry were designed to accommodate the needs of the major Czech industries of the time; in particular, the iron, glass and textile industries. During its long history many important alumni have studied at the faculty, with Otto Wichterle, the inventor of contact lenses, and Vladimir Prelog, the 1975 winner of the Nobel Prize for Chemistry, being the best known.

Research conducted by the departments of the faculty can be divided into five main streams:

(i) Chemistry and chemical technology.

(ii) Materials science, technology and engineering.

(iii) Technology of pharmaceutical substances and medicinal applications.

(iv) Technology of the conservation and restoration of historical monuments.

(v) Informatics in chemistry and biochemistry.

The first stream, **chemistry and chemical technology**, is divided into various specializations that focus on inorganic and organic chemistry, as well as on particular subjects related, on the one side, to the interests of ICT Prague's industrial

partners and, on the other side, to the emerging technologies intensively studied in industrially developed countries.

Research in inorganic chemistry is mainly focused on coordination chemistry and the correlation between the electronic structure of various compounds and their reactivity. Research in organic chemistry covers important topics in both theoretical and computational organic chemistry (quantum organic chemistry, molecular modelling), and the synthesis and reactivity of organic compounds (transition metals in organic chemistry, chemistry of heterocycles, fluoroorganic chemistry, chirality). Attention is also focused on supramolecular chemistry (calixarenes, crown-ethers, amidines, liquid crystals), organocatalysis (flavines catalyzed oxidations, fluorophilic Grubbs catalysts), the design of novel pharmaceutically active substances (modified nucleobases, acetylcholine esterase inhibitors), and materials applications (organic electronics, switches). Last, but not least, is a growing focus on the synthesis of DNA adducts and their utilization in DNA diagnostics.

The development and optimization of various kinds of chemical technologies is a special area of interest. Attention is focused on classical technologies, such as the processing of oil fractions, industrial fertilizers and various fine chemicals (fragrant substances, food additives, etc.), as well as on specific problems, including electrochemical synthesis, and improving electroplating and electrochemical polishing. The approach used in the design and optimization of chemical technologies is based on a deep theoretical understanding

and detailed description of the individual processes. Such an approach enables the utilization of modern software tools (ASPEN Plus, HYSYS) for highly efficient work.

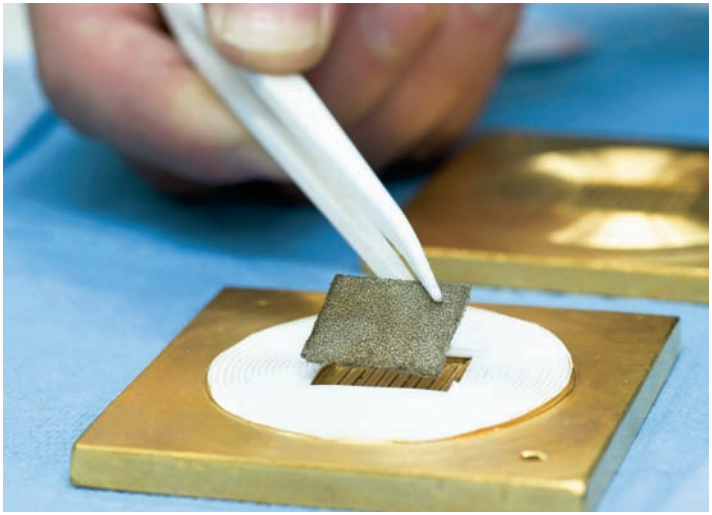
Besides the design and optimization of various industrial technologies intensive research is carried out into emerging processes in the faculty laboratories. This research may be divided into the several areas described below.

The most important area is that of environmentally-oriented technologies. Apart from classical wet oxidation, this also includes new processes based on membrane separation, electrochemical treatment, and advanced oxidation processes for the separation and decomposition of waste, such as the photocatalytic decomposition of highly persistent wastes.

Another important topic is the development of new types of chemical reactors that enable significantly cleaner and more efficient processes. Closely related to this is the development of new catalysts for both classical processes and new reactions systems. This research is accompanied by the study of transport phenomena in porous media (e.g. zeolites), as well as by research into progressive technologies, such as membrane processes and water electrolysis for hydrogen production and fuel cells.

The second stream, **material sciences and engineering**, is split into organic materials and inorganic materials, with the latter being further subdivided into metallic

and non-metallic materials. In terms of organic materials, research is focused on the synthesis and modification of classical polymers, as well as on controlled polymerization for the development of custom-made materials. Because the last decade has seen growing demand for the development of biodegradable materials,

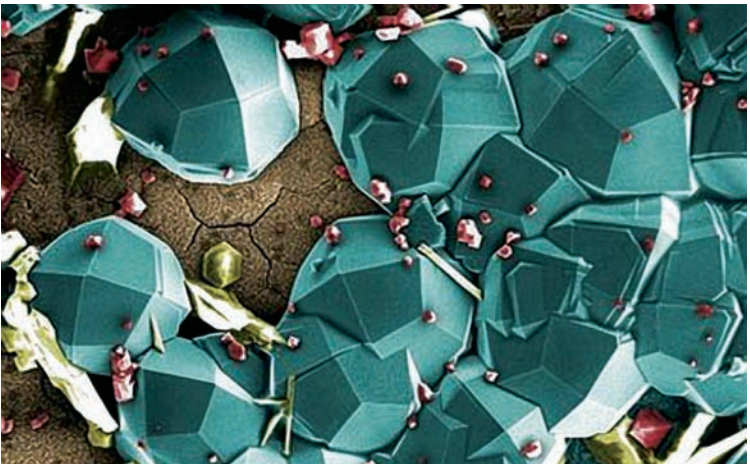


special attention is given to the recycling and processing of polymeric waste. Recently, polymer nanocomposites, nanofibers and biocompatible films have become key areas of research due to their high potential for practical use.

Research into metallic materials is focused on the recycling of various metals and their recovery by means of hydrometalurgic techniques. Importance is also placed on the preparation and study of high-temperature materials and nanocrystaline light alloys. Within the framework of energy-related research, special alloys in the form of metal hydrides are developed for hydrogen storage. Also integral to this area is research into the corrosion stability and corrosion protection of individual metallic materials.

Research into inorganic non-metallic materials is focused on new types of inorganic binders, glass and ceramics. This is closely related to the theoretical disciplines of transport and colloid phenomena in ceramic technologies, to the modelling of melting processes and to the modelling of glass structures. Besides the development of new materials, the stability and durability of glasses is studied, including the mechanisms of glass corrosion. Another class of inorganic materials studied

are the materials used in magnetic oxides, thermoelectric devices, optical waveguides, high-temperature superconductors, diluted magnetic semiconductors for spintronics, and $A^{III}N$ semiconductor-based microelectronic and energy applications. Study of this type of materials requires the development and utilization of advanced synthesis techniques, such as MOVPE, ion implantation and single crystal growth. Also important in materials research at ICT Prague is the availability of a broad spectrum of characterisation methods: calorimetry analysis, thermal analysis,



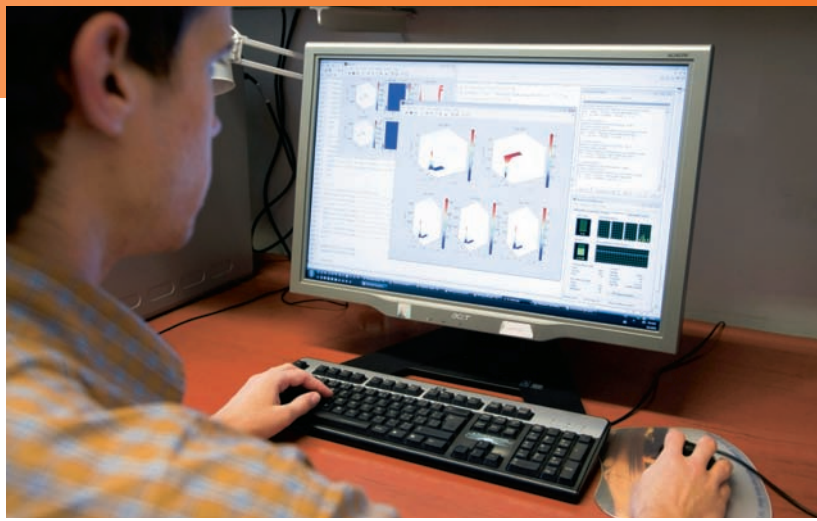
optical microscopy, SEM microscopy, X-ray diffraction, wave mode spectroscopy, luminescence spectroscopy, measurement of magnetic and transport properties, determination of texture characteristics, and calculation of specific active surface. The experimental techniques used are complemented by first-principle calculations of electronic structure and by thermodynamic modelling.

The third main research stream is focused on two main directions: the **technology of pharmaceutical substances**, **and their medical applications**. The first involves the synthesis of pharmaceutical substances, including their detailed chemical and structural characterization. The main subjects of interest are stereoselective heterogeneous catalysts, modified compounds and homogeneous catalytic complexes. Considerable attention is being paid to the heterogenization of homogeneous catalysts by means of anchoring a homogeneous catalyst on a suitable support matrix while retaining its original stereo-selectivity; successful anchoring enables the catalytic complex to be more easily separated from the reaction

mixture. Consequently, a specific focus is the development of separation techniques based on the application of magnetic micro-

or nanoparticles carrying a specific partner for the isolation of target compounds; separation is then carried out using an external magnetic field. Theoretical research is followed by the design, optimization and validation of selected processes common in the pharmaceutical industry, such as wet granulation, powder blending, or tablet compressing. The second research direction is oriented towards the development and testing of biomedical materials. In particular, this concerns the development and modification of implants more compatible with the human body. The materials studied include metallic, polymeric, ceramic and composite ones. Both bioinert and bioactive materials are prepared and tested using *in vitro* methods.

The long history and architectural richness of the Czech Republic makes the **conservation and restoration of historical monuments** another important area with numerous practical applications. Research is focused on identifying the materials used in historical monuments, on understanding the origins and mechanisms of damage, and on the design of new methods for the analysis, conservation or restoration of such monuments. Studies include the treatment



of archaeological finds, and the interaction of glass and ceramic surfaces with different soils, solutions and atmospheres. In terms of organic materials, research is focused on wood, textiles, leather, paper and photographs.

The fifth research stream, **informatics in chemistry and biochemistry**, includes XML technologies, electronic publishing, data mining and bioinformatics. The faculty members are a driving force behind the electronic publishing activity of the International Union of Pure and Applied Chemistry (IUPAC). The team at the Laboratory of Informatics and Chemistry authored the flagship IUPAC electronic publication, the XML Gold Book, and is responsible for IUPAC's web portals.

Together with the university publishing house ICT Prague Press, the Laboratory of Informatics and Chemistry created an electronic publishing system that offers many free electronic books covering different aspects of the technical and natural sciences. Several advanced electronic encyclopaedias also resulted from this partnership. Within the field of bioinformatics, the research focuses on the application of artificial intelligence to the classification of biomolecular structure, as well as on the statistical and data mining processing of high-throughput experimental data.

Because these fields of research are closely linked to the accredited degree programmes offered by the faculty at all three study levels (B.Sc., M.Sc., Ph.D.), it is possible for students to select one of these fields for their future specialisation.

During bachelor studies, all students are introduced to the fundamentals of chemistry and materials science. They are given a theoretical basis that covers general chemistry, inorganic chemistry, organic chemistry, physics, physical chemistry and chemical engineering.

Once they have a firm grasp of the theoretical fundamentals, students can become highly specialized by attending one of the faculty's high-quality master's or doctoral study programmes.

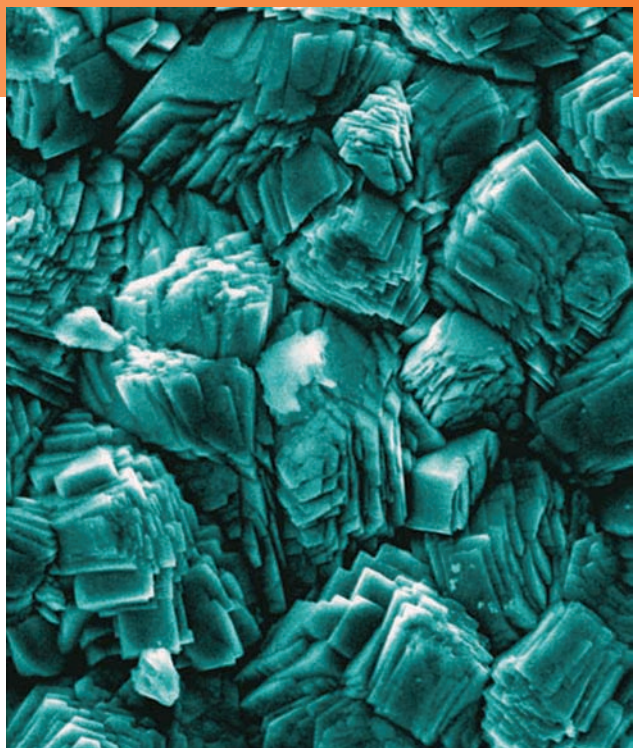
In chemical technology, these programmes include the following cutting-edge fields: progressive chemical synthesis and techniques suitable for the preparation of promising new molecules; process design and development; the preparation and characterization of catalysts; reactor design and control; membrane processes, including processes for energy production.

Students opting to go in the direction of materials science and technology acquire a deep knowledge of the preparation and production of a broad range of both classical and progressive materials (including nanomaterials and biomaterials), together with their characterization, mechanisms of degradation and methods of stabilization.

Students specialising in the technology of pharmaceutical substances and medical applications are educated in the following: pharmaceutical process engineering; the chemistry and physics of pharmaceuticals, drug design; drug registration and patent protection; related aspects of materials engineering and testing.

Advanced studies in the field of the conservation and restoration of historical monuments can be divided into two main strands. The first, which involves the provision of higher education in artistic subjects (provided in cooperation with the

Hydrogen-powered bus



Academy of Fine Arts, Prague) and other specialised subjects, prepares practical conservation and restoration specialists. The second, more theoretical, strand educates specialists in the materials science related to the conservation and restoration of historical monuments. Their task is to develop new materials, processes and techniques for application within the field.

In the field of informatics, advanced educational activities centre on the teaching of chemical informatics and bioinformatics, data mining, XML and Python programming. The team members founded Zvon.org, a highly visited educational and experimental site used by many universities around the world and cited in 170 international books.

more information and pictures at

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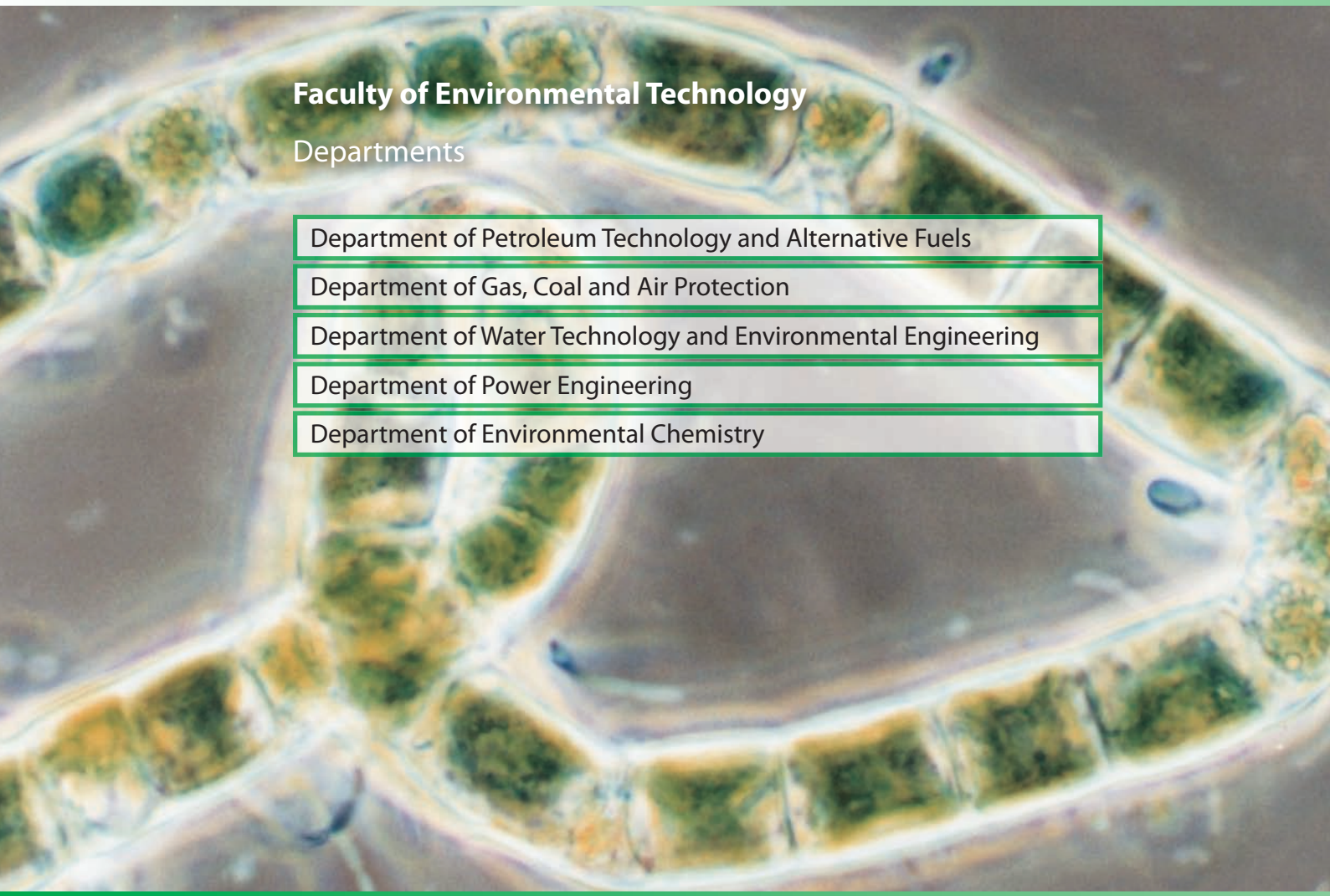


Faculty of Environmental Technology

Departments

- Department of Petroleum Technology and Alternative Fuels
- Department of Gas, Coal and Air Protection
- Department of Water Technology and Environmental Engineering
- Department of Power Engineering
- Department of Environmental Chemistry

Faculty of Environmental Technology

Faculty of Environmental Technology

The scientific disciplines that form the basis for the teaching and research activities of the five departments of the faculty were first taught back in 1884/85, when Prof. František Štolba began teaching one of the oldest subjects of chemical technology: technologies of fuels, light sources and water. The next development in this field took place in 1910, when assistant professor (later, professor) Ferdinand Schultz, the first specialized teacher of these subjects, officially established the Department of the Technology of Fuels and Water.

This department laid the basis for the Faculty of Fuels and Water Technology, which was established in 1953. From the 1980s, environmental technology became predominant in the faculty's activities, and, consequently, in 1991, it acquired its current name.

Today, the faculty enjoys a high reputation in the field of environmental technologies and participates in many international projects (e.g. within the European Framework Programmes)

Research conducted by the departments of the faculty can be divided into six main streams:

(i) Petroleum processing and the utilization of petroleum products and alternative fuels.

(ii) Air protection and gaseous fuels.

(iii) Biomass as a source of heat and energy.

(iv) Power engineering and corrosion phenomena.

(v) Water and wastewater treatment.

(vi) Monitoring, assessment and remediation of contaminated subsurface.

Research into **petroleum processing and the utilization of petroleum products and alternative fuels** is focused in the following directions: analysis of crude oils, crude oil fractions and their products; transportation and storage of crude oil; quality improvement of motor fuels and lubricants; lubrication.

The first of these directions focuses on the development and optimization of procedures that use a combination of various, mainly instrumental, methods (e.g. GC, HPLC, LSC, MS NMR) for the detailed analysis of gasoline, middle distillates and high-boiling crude oil fractions, including crude oil residues. The analytical procedures developed and optimized are applied to problems encountered while researching the topics listed above.

The transportation and storage of crude oil is evaluated with respect to sludge deposition during long-term storage, with detailed analyses of the sludge formed being performed. Special attention is paid to the behaviour of the high molecular n-paraffins and asphaltenes that decisively contribute to sludge deposition. Also studied are the influence of crude oil composition on its low-temperature properties, and the possibilities for improving the properties of crude by using suitable additives.

The quality improvement of motor fuels comprises two topics: the catalytic hydrotreating of crude oil middle distillates used for diesel fuel blending, and the utilization of alternative fuels in transport. The properties of alternative motor fuels are investigated, particularly those of bioethanol, biobuthanol, fatty acid methyl esters and fractions from Fischer-Tropsch synthesis, The influence of alternative fuels addition on physicochemical properties of motor fuels, gasoline and diesel, is also evaluated. Also studied are standard exhaust emissions (C_xH_y, CO, NO_x and particulate matter), the emissions of individual types of hydrocarbons (including aromatics, polyaromatics and aldehydes) formed on the combustion of these mixtures, and gaseous fuels in automobile internal combustion engines.

Experimental work in the area of lubricant chemistry is focused on testing the properties of lubricants to assess their suitability for use as motor and/or industrial oils and as lubricating fluids. Along with traditional tests, advanced instrumental analytical techniques are applied to evaluate the properties of both existing and new lubricants. A combination of research experience and comprehensive oil analysis is used to provide expert examination of failures in both the automotive and industrial fields.

Research in the faculty is also aimed at **air protection and optimizing gaseous fuel utilization**. In terms of the removal of volatile organic compounds from aerosols, the focus is on the processes of catalytic combustion and biofiltration, as well as on adsorption based on active carbon and zeolitic materials. At both laboratory and industrial scales, the effect of various adsorbents on the removal of hydrogen sulfide, ammonia, formaldehyde and volatile organic compounds is observed, and the possibility of increasing the adsorption capacity of these sorbents is investigated.

In the departmental laboratories, measurement instruments are modified and improved so that emissions from various sources can be monitored in very great detail. The possibility of using both wet and dry methods to reduce SO_2 and other pollutant emissions is pursued.

Also in the area of emissions, attention is focused on the mechanisms of ozone formation and on monitoring the concentrations of a selected group of analytes in discrete air samples taken at elevated locations in the Czech Republic. The aim is to determine the direction of movement over the Czech Republic of both inorganic and organic air contaminants.

Another area of research involves optimizing the utilization of the natural gas pipeline system. The physical and transport properties of model mixtures of gaseous fuels under high pressures is investigated so that modern methods can be applied to the measurement of gas flow and consumption. Data is collected to simulate gas transmission and distribution, and to model pipeline and gas storage accidents.

In partnership with the Department of Power Engineering, unique research is being conducted into pipe corrosion under stress. Firm foundations have also been laid for research into the drying of natural gas using glycols under elevated pressure, the desulfurization of natural gas by solid sorbents and the odorization of natural gas by sulphur-free compounds.

Biomass as a source of heat and energy is studied to support the possible increased utilization of non-traditional energy. Specific projects here deal with gasification and the development of a pilot fluidized-bed pyrolysis unit. Part of this research is focused on increasing boiler integrity and lifetime by preventing the corrosion of its construction material by alkali, chlorine and sulfur compounds present in the flue gas. The formation of glass-like ash on the boiler and furnace walls is investigated with the aims of preventing its formation and improving heat transfer. The composition of burning products (both gas phase and particulate solid matter) is evaluated with respect to its possible harmful effects. Analysis is conducted using state-of-the-art instrumental methods, including high-resolution mass spectrometry and/or X-ray fluorescence.

Methods such as thermogravimetric analysis and microcalorimetry are used to investigate the properties of biomass and waste materials as a source of gas that serves as a raw material for the synthesis of fuels and other chemicals. IR-spectroscopy is used to analyze the products of pyrolysis in a thermogravimetric unit.

Concerning materials science, research is conducted into the materials used in **power engineering**, with **corrosion phenomena** being a particular interest. Studies of corrosion protection focus on the practical problems of materials used in the fuel and power industries, with hydrogen embrittlement and stress corrosion also investigated. A key aim is to develop new highly-resistant protective coatings. Recently, the corrosion properties of biofuels have begun to be investigated. Research involves the use of acoustic emission, electrochemical noise and electrochemical impedance spectroscopies. For materials and surface analysis, electron spectroscopy for chemical analysis (ESCA) is available. Research in this area is closely connected to practice.

Current research in the field of **water and wastewater treatment** is focused on the development of innovative technological processes that address the following global problems: deficit of water resources; low water quality; wastewater recovery and reuse; the need for more energy-efficient wastewater treatment.

Studies into progressive drinking water treatment processes include the removal of priority pollutants, the removal of volatiles and gases, the removal of heavy metals, the biological stability of drinking water, and oxidation using various oxidation agents.

Research into biological wastewater treatment also has a long tradition in the faculty. Results of its studies of nutrient removal, improvements in anaerobic digestion, and the population dynamics of activated sludge are widely known.

The complex tasks of hydrochemistry and water analysis include the assessment of pollutants, such as pharmaceuticals and personal care products, which are present in water in extremely low concentrations.

Faculty members are actively involved in the international standardization of biodegradability tests for organic substances, as well as in the standardization of tests of the activity of specific bacteria under anaerobic and aerobic conditions.

The optimal treatment of sludge produced in biological wastewater represents a key challenge for modern wastewater treatment plants. Thermophilic and temperature-staged anaerobic digestion, microaerobic digestion and sludge disintegration are the main tasks addressed.

The other field of research, the desalination and purification of industrial, process and drinking water, is accomplished by sorption processes, ion exchangers and the use of membranes. The removal and recovery of metals and other undesirable compounds from wastewater streams is carried out by the use of highly selective ion exchangers, selective sorbents, biosorbents and composites. Attention is also paid to the removal of harmful substances from drinking water. Ionic chromatography, atomic absorption spectroscopy and ion-coupled plasma emission spectroscopy are utilized to evaluate the technological processes designed.

Microbiological and hydrobiological research is carried out in support of technological studies. This research is also applied to the evaluation of water resources and treatment methods.

Research in the field of the **monitoring, assessment and remediation of contaminated subsurface** is primarily aimed at understanding the chemical and microbiological impacts on the environment that result from human activities, as well as at understanding the effects of subsurface contaminants on human health and the ecosystem. The main goals of this research are to achieve a detailed understanding of the distribution, transport and fate of subsurface contaminants, and to derive effective technical and methodological tools for improving subsurface quality. The scientific activities of this field take place in specialized laboratories equipped with the modern instrumental infrastructure needed for precise analytical work and technological simulations.

Subsurface contamination research is grouped into four thematic areas, each of which employs a high number of Ph.D. students:

(i) Technologies for soil and groundwater remediation.

(ii) Surface waste deposits.

(iii) Ecotoxicology.

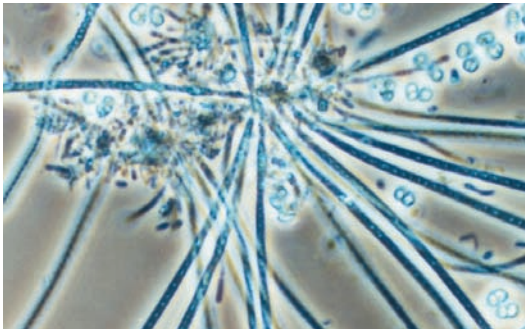
(iv) Legislation and economic tools for preventing subsurface damage.

Research on subsurface remediation technologies focuses on the following areas: development and implementation of processes based on the principles of in-situ chemical oxidation/reduction (e.g. application of potassium permanganate, hydrogen peroxide, elemental nanoiron); thermal treatment of contaminated soils (thermodesorption with classic and microwave heating); washing of contaminated soil with surfactants;

membrane treatment of contaminated groundwater. Studies on surface waste deposits are related to the potential risks that follow from the introduction of 'nontoxic' wastes (e.g. building waste, solid residuals from coal incineration) to unprotected open areas, such as former sandpits. Ecotoxicological research is mainly aimed at the development and implementation of reliable and easy-to-interpret ecotoxicological tests (both aquatic and terrestrial) that are applicable to both soil and groundwater contamination. These tests are developed as complementary tools to the current techniques of chemical analysis. Finally, research on the legislative and economic aspects of subsurface contamination aims to increase the efficiency and cost-effectiveness of all monitoring, assessment and remediation activities related to the field of subsurface contamination. LCA (Life Cycle Assessment) is an example of the type of tool applied in this area.

The research fields described above are closely linked to the educational programmes offered by the faculty at all three study levels (B.Sc., M.Sc., Ph.D.).

The Faculty of Environmental Technology actively involves its students in the solution of practical environmental issues. It has strong international links with foreign universities and research institutions, which results in intensive student exchange.



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Faculty of Food and Biochemical Technology

Departments

- Department of Biotechnology
- Department of Biochemistry and Microbiology
- Department of Carbohydrate Chemistry and Technology
- Department of Dairy, Fat and Cosmetic Science
- Department of Food Analysis and Nutrition
- Department of Food Preservation
- Department of Chemistry of Natural Compounds

Faculty of Food and Biochemical Technology

Faculty of Food and Biochemical Technology

The teaching of food chemistry and technology has a long-standing tradition in the Czech lands, and is closely connected with the teaching of chemistry and chemical technology. It was in Prague, in 1806, that food chemistry was introduced as an independent university subject for the first time anywhere in the world.

An unprecedented expansion in food production occurred after 1945, and fields that had previously existed as separate trades became incorporated into the food industry. While several universities offered the teaching of food chemistry and technology, none of them provided a sound engineering basis. As the concept of a faculty of food technology was conceived and the profile of its future graduates discussed, attention focused primarily on the needs of the managers of this modernized food industry. The knowledge of technological processes, together with their engineering and economic aspects, was identified as the major requirement. It was also necessary to meet the needs of both the traditional industrial fields, such as fermentation technology, sugar manufacture, the milk and fat industries, and the fields that were just beginning to expand, such as meat processing, milling and baking, food preservation, freezing, poultry processing, biochemistry, microbiology etc. Thus, in 1952 the Faculty of Food Science was established as part of the newly independent Institute of Chemical Technology. The faculty took the name Faculty of Food and Biochemical Technology in the academic year 1969-1970.

The basic and applied research in the faculty covers traditional and modern topics of food science and a wide range of biodisciplines. The faculty departments pursue research addressing current issues and trends in such areas as:

- **Food chemistry and analysis; food safety, quality and innovation.**
- **Biotechnology aimed at renewable energy resources; environmental protection and restoration; construction of novel industrial strains; process engineering.**
- **Biochemical and biological disciplines focused on molecular biology.**

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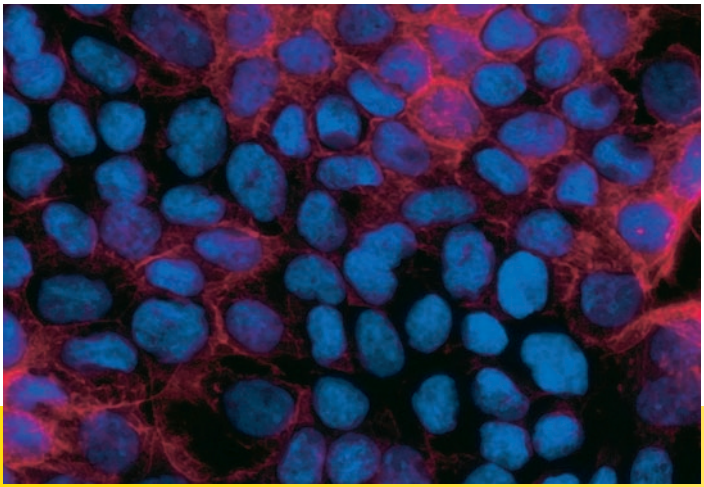
- **Bioanalytical techniques; forensic analysis; therapeutic applications; advanced organic chemistry of natural compounds.**

Applied Biology and Genetics

Several groups within the faculty conduct extensive basic and applied research into areas focused on human health, biological activity, monitoring and protection of the environment, food safety, and natural products.

Research in the medically-oriented groups focuses on enzymatic synthesis, anticancer therapeutics and tumour imaging, biocompatibility of materials for medical applications, obesity research, plant antimicrobial peptides, and the retroviral life cycle. Research in the environmentally-oriented groups can be divided into two branches. The bioanalytical branch develops methods for monitoring the environment using advanced immunoassays, proteomics and other bioanalytical approaches. The second branch investigates and develops ways of protecting the environment: by the removal of toxic contaminants using wild or genetically modified plants; by the removal of toxic contaminants using microbes and their communities; by the biological accumulation of heavy metals; by the use of signal transduction mechanisms in plants.



Food safety research is focused on the development of rapid techniques for the detection of pathogenic microbes, together with their identification and characterization. A growing area of interest is the detection of undeclared genetically modified content in food.

Research in these areas is supported by advanced instrumentation and facilities for mass spectrometry, microscopy (optical, fluorescence, electron, atomic force), cell culture techniques, and the expression of

recombinant proteins and determination of their structures, amongst others. The faculty holds a large collection of microorganisms and provides certified microbiological analysis of food.

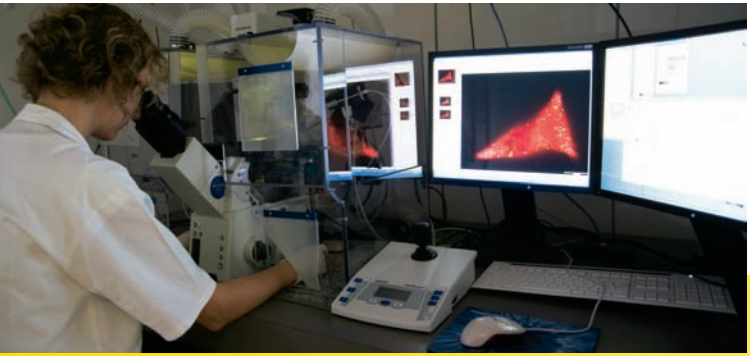
The study of natural products is focused on the chemistry of saccharides, phenolics, steroids, porphyrins, bioactive amines and other groups of natural compounds. Three working groups are oriented to organic synthesis, while another two deal with analytical and computational methods. Their research covers the following topics: partial reactivity and stereochemistry, chirality of molecules, protecting groups and their orthogonality; use of natural compounds as chirality and self-assembly modifiers; synthons, components of supramolecules and nanodevices; isolation and characterization of compounds from natural sources, study of raw materials used in the pharmaceutical and food industries; phytochemical studies oriented to phenolics, steroids and triterpenoids, including

their glycosylated forms; development of chromatographic, electrophoretic and immunoanalytical techniques for analytical applications and for isolation on a preparative scale.

Computational methods are an integral part of this research: computational modelling of chemical structures and reactions; conformational analysis; study of super-assembly mechanisms using semi-empirical computational methods; prediction of spectra (IR, NMR, VCD) using ab initio/ DFT computational methods; prediction of pharmacologically-relevant parameters.

Food Chemistry

Research in the field of food chemistry is another load-bearing area of scientific work at the faculty. Individual groups are focused on the following areas of research.

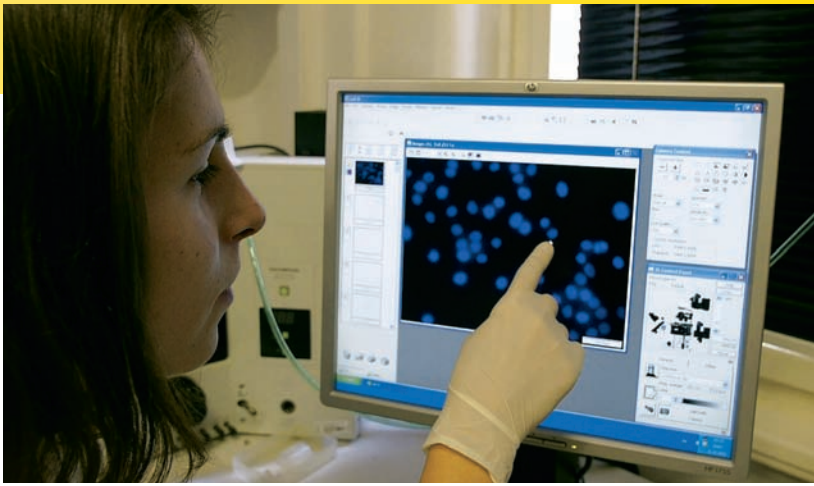


Studies of the chemical reactions in food, particularly **(i)** the Maillard reaction resulting in the formation of flavour-active compounds, and **(ii)** lipid oxidation, and lipid reactions with other food components.

Modern analytical methods, employing novel, challenging technologies, are successfully developed and optimized for the identification and quantification, in complex mixtures, of various biologically active molecules, both health promoting (antioxidants, anticarcinogens etc.) and toxic (natural and processing contaminants, pesticide residues and environmental pollutants).

Much attention is focused on the environmental fate of the emerging contaminants/toxicants and nanoparticles that arise during domestic and industrial food processing and storage. Studies in this area include the proposal and development of mitigation strategies.

Essential to ensuring the high quality of food is the implementation of novel authentication and traceability approaches able to determine the origin of foods/food supplements, their processing history and



the way in which they were farmed (organic versus conventional methods).

Scientific advice on recent trends in food quality and safety, together with solutions to emerging problems in these fields, are provided for both government institutions and private food companies.

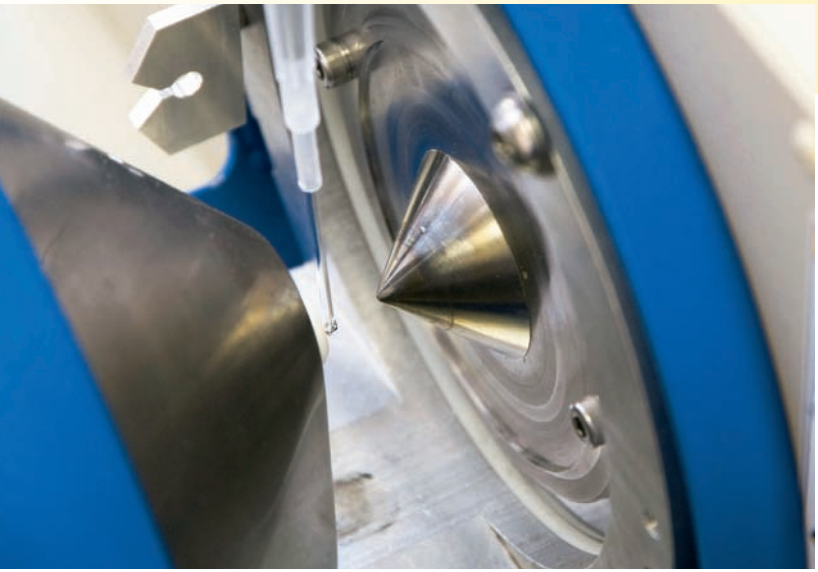
Food Engineering and Advanced Technologies

Almost every department in this faculty covers areas related to food processes in its scientific programmes. Consequently, the faculty play an important role in introducing new technologies to, and developing new products for, the dairy, meat, bakery, sugar, beverage, canning and packing industries. Development work carried out for the fat industry covers not only food, but also cosmetics.

Great attention is paid to food safety and quality management systems (implementation of the standards HACCP, ISO 22000, 9001, IFS, BRC, GlobalGAP, etc.). Auditing, quality systems maintenance, defects expertise, and certification (in partnership with several national and international certification bodies) are all services provided for industrial enterprises.

These activities are only possible because of the high-quality scientific research conducted into several areas.

Separation processes are an essential area of research. Here, the experimental activity fully accords with the contemporary expansion in separation techniques developed in food-processing and biochemical technologies. Some of the processes studied are at the cutting edge of food processing research, e.g. membrane reactors, cross-flow ultrafiltration on ceramic membranes (the faculty possesses pilot-plant devices). The development of membrane



processes is one of the main trends of research. The membrane technologies developed are used in combination with other processes for the design of new and modified technologies, e.g. to replace the environmentally-demanding chemical purification of natural extracts.

The potential for product purification by nanofiltration is studied in a number of food processes. The possible application of nanofiltration for the concentration and desalination of extracts is investigated and verified.

SMB (Simulated Moving Bed) is a modern technique of interest to many foreign research centres. SMB is a form of continuous preparative chromatography, which, because it is able to separate particles and/or chemical compounds that would be difficult or impossible to separate otherwise, widens the potential application of separation techniques. The use of this promising technique is being verified for the purification and separation of sugars, the separation of components from fermentation mash, the purification of proteins, and the separation of enantiomers. Also in this context, considerable attention is paid to the processing of whey, the evaluation of whey components by membrane processes, and the isolation and modification of whey proteins.

The physicochemical properties of food and cosmetics is another research area directly related to improving product quality. Research in this field includes the rheological properties, texture and colloidal stability of dairy, fat and cosmetic products, and the functional properties of hydrocolloids. The group focused on cosmetics investigates the use of fatty acids and their derivatives in the synthesis of surfactants and emollients for cosmetic emulsions. Research is also devoted to the physicochemical properties of new detergents, and their use in cleaning and washing products.

Biotechnology

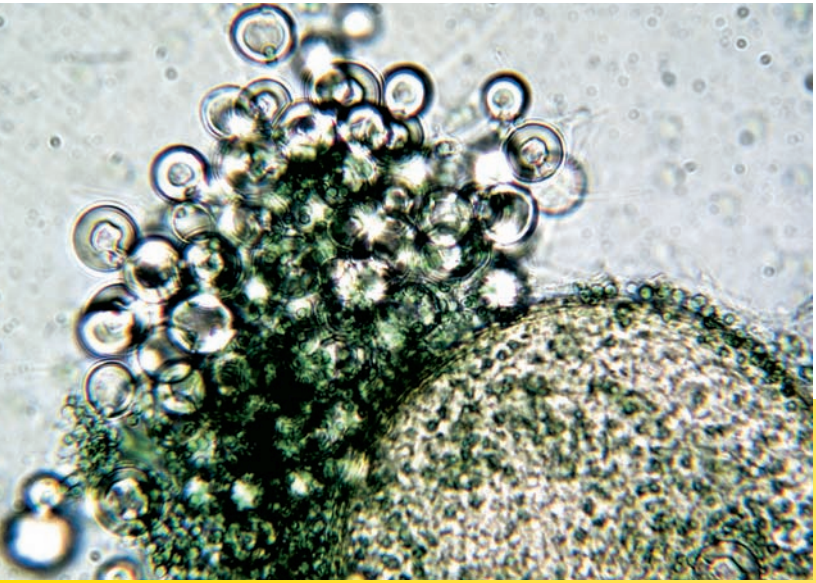
Biotechnological processes have been studied at the faculty since its establishment. While the traditional focus has been on malting, brewing and other classical fermentation technologies, such as distillery and baker's yeast production, research on the processes of dairy biotechnology is also highly significant.

The brewing industry is economically powerful and, thus, at the forefront of technological development. The research topics in this area of biotechnology are focused on the verification of novel methods/technologies and their industrial implementation. For this reason, amongst others, a research centre was established to study the extract compounds of barley and hop. Research in brewing technology is also focused on the formation, stability and decay of beer foam. And studies on the health risks associated with the presence of fusarium mycotoxis in raw materials are becoming ever more important.

In terms of dairy biotechnology, the focus is on the protective and probiotic effects of lactic acid bacteria that have an impact on the production of bacteriocins and antifungal metabolites. With respect to

improving the microbial quality of products and increasing their shelf-life, another area of interest is the development of starter cultures and their use in dairy processes.

Experience with traditional ethanol production processes is currently being applied to research into renewable energy sources for transportation. Biofuels are produced in steadily increasing amounts, mainly from crop plants containing starch and lipids. However, for the biofuel vision to be viable, novel sources must be found and feasible large scale production methods must be developed. One direction being evaluated at pilot-scale is biobutanol production technology. Another area being investigated is the use of flue gas CO_2 as a carbon source for the production of biofuels from microalgae with a high content of starch and lipids. Attention is also being paid to the cell membrane lipids of thermophilic bacteria.



Biotechnology is most rapidly developing in the area of environmental processes. Research in this area is focused on the nature and mechanisms of microbial adhesion and biofilm processes. The microbial degradation of xenobiotics deals mainly with the characterization and modulation of biological elements tailored to the proposed engineering approach of the environmental technology. In this context, the genetic and physiological modulation of bacterial strains is studied, together with the development of tools that additively enhance soil and water bioremediation. The various research groups have developed both reactor technologies (biotrickling filters, fluidized biofilm-based reactors, permeation reaction biobarriers, etc.) and *in situ* technologies (bioventing, biosparging).

The faculty offers education at all three study levels (B.Sc., M.Sc., Ph.D.). All bachelor's and master's degree programmes are designed to provide a balanced combination of education in the natural sciences (mathematics, chemistry, biology,

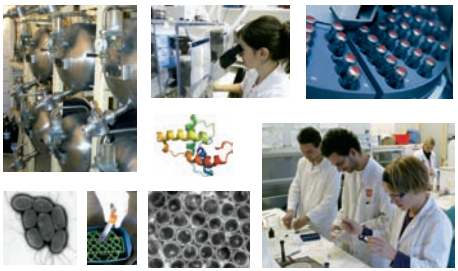
etc.) and engineering (chemical engineering, bioengineering, bioinformatics, economics), with particular emphasis on individual work in laboratories. Studies are based on a credit system that allows students to create a study plan comprising the courses most appropriate to their future profession.

The aim of the bachelor's degree programme **Food Chemistry and Technology** is to educate specialists for the food and biotechnology industries, for control and inspection institutions, for commerce and for state administration. Subprogrammes allow greater specialization in **Food Technology**, **Food Chemistry and Analysis**, or **Biochemistry and Biotechnology**. In 2009, in collaboration with the Faculty of Chemical Technology, new bachelor's and master's degree subprogrammes were opened in the field, **Biotechnology of Drugs**. This new field of study was developed because of the increasing demand for qualified professionals in the rapidly-growing pharmaceutical industry.

The master's degree programmes provide extensive education in scientific disciplines, such as molecular biology and genetics, microbiology, applied biology, food chemistry and analysis, and the chemistry of natural compounds. Graduates are prepared not only for scientific careers, but also for the management, control and development of technological processes in the food and biotechnological industries The faculty offers three master's programmes (**Biochemistry and Biotechnology, Food Chemistry and Analysis, Food Technology**), which are further divided into 8 subprogrammes.

Postgraduate studies (Ph.D.) are an integral part of the scientific and educational activities of the faculty. A doctorate can be obtained in the fields of **biochemistry**, **organic chemistry**, **microbiology**, **biotechnology**, **food technology**, and **food chemistry and analysis**.

Since its foundation, a key belief of the faculty is that practical scientific work is essential to quality education.



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Faculty of Chemical Engineering

Departments

- Analytical Chemistry
- Physical Chemistry
- Chemical Engineering
- Mathematics
- Laboratory of Chemical Robotics
- Economics and Management of Chemical and Food Industry
- Physics and Measurements
- Computing and Control Engineering

Faculty of Chemical Engineering

Faculty of Chemical Engineering

The Faculty of Chemical Engineering has its origins in the Prague School of Chemical-Technological Engineering founded in 1920 as part of the Czech Technical University. In 1960, the Faculty of Chemical Production, Automation and Economics was established in response to the need of the chemical industry to enhance its process and economic disciplines, as well as its chemical ones. It consisted of four departments: Mathematics; Physics; Processes and Apparatus; Economics and Management of the Chemical and Food Industries. In 1969 it was renamed the Faculty of Chemical Engineering. In 1973, the Department of Automated Control Systems in the Chemical and Food Industries (later renamed the Department of Computing and Control Engineering) was added. Further expansion of the faculty came with the inclusion of the Department of Analytical Chemistry and the Department of Physical Chemistry, both of which built on a rich research history. Today, the faculty consists of 7 departments.

Research conducted by the departments of the faculty can be divided into six main streams:

(i) Chemical engineering; modelling and experimental verification of systems involving hydrodynamics, mass transfer and/or chemical reactions; dynamics of chemical and biological systems; chemical robotics.

(ii) Measurement, analysis, modelling and control of processes and systems of chemical technology, biotechnology and bioengineering; information engineering; signal and image processing; computer vision and control engineering.

(iii) Management systems in the food and chemical industries: design, modelling and simulation; marketing, logistics and financial collaboration in supply chain management.

(iv) Molecular modelling and simulation; structural, spectroscopic and thermodynamic properties of

environmentally or biologically important substances and their complexes.

(v) Physical, physicochemical and chemical measurements and analyses; advanced separation techniques including chromatographic, electromigration and hyphenated techniques; physical and chemical sensors; molecular recognition.

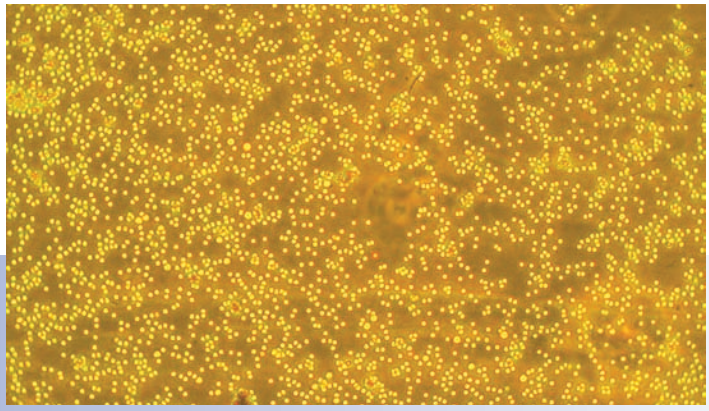
(vi) Biospectroscopy; atomic spectroscopy together with speciation analysis; molecular spectroscopy, including chiroptical methods; high resolution spectroscopy.

The first of these streams is focused on various aspects of **chemical engineering**, ranging from the scale-up design of industrial apparatus to complex reaction-transport phenomena to scaled-down processes and microfluidics. Among the main issues researched are: modelling of complex mixtures in crude oil distillation and pyrolysis reactors; hydrodynamics of multiphase-systems and their simulation; dynamics of bubble-particle agglomerates; characteristics and mechanism of mass transport in absorption and distillation columns, standardization and scale-up design; dynamics of the removal of noxious gases from catalytic converters; processing and characterization of polymeric materials and modelling of polymer morphology; fermentors for wastewater bioremediation coupled with electrokinetic transport; design of microstructured reactors and their use in microfluidics, such as bioanalytical applications of microfluidic chips; nonlinear dynamics of (bio)chemical systems and functional dynamics of organisms. Mathematical approaches, including numerical methods for non-smooth systems, are applied to dynamical systems.

The **Chemical Robotics Laboratory** hosted by the faculty was established in 2008 on the launch of the CHOBOTIX project. The aim of the project, which is funded by the European Research Council, is to develop chemical processing systems based on the principle of swarm robotics. The main scientific challenge is the design

and synthesis of chemical swarm robots ('chobots'), which are envisaged as internally structured particulate entities in the size range of 10-100 μm. These 'chobots' can move in the environment, selectively exchange molecules with their surroundings in response to changes in temperature or concentration, chemically process those molecules and either accumulate or release the product. Such active autonomous entities can be viewed as simple pre-biotic life forms, although without the ability to self-replicate or evolve.

The second stream is oriented to the interdisciplinary area of **measurement techniques**, **data analysis and processing**, **computational intelligence** and **system control**. Research in the area of information engineering and digital signal and image processing is aimed at multidimensional data analysis. Research studies cover the following topics: theoretical background of data processing; discrete Fourier transform; wavelet transform in signal and image processing; principal component analysis; orthogonal decomposition and reconstruction; parallel computational algorithms. Research into digital signal processing and computer vision involves system modelling, numerical methods, artificial neural networks, signal denoising, segmentation, classification and prediction



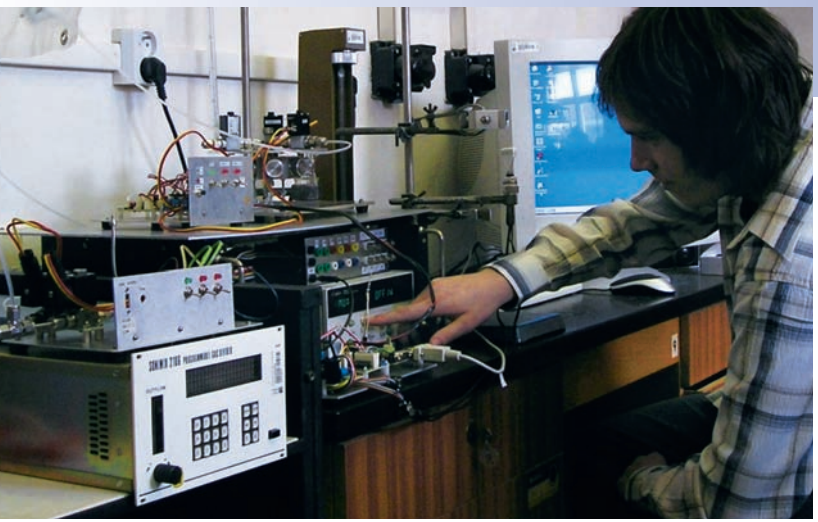
with applications in environmental protection, biomedical data processing, prediction of energy consumption, microscopic data analysis and video data processing. Specific attention is paid to the numerical control of technological processes, the design and realization of computer control systems and the application of artificial intelligence. Research in the area of bioprocess control is based upon the classification of metabolic stages and the physiological control of cells using on-line measurements of bioreactor components. Further research is devoted to the design of a multi-agent knowledge system for the biopolymer production process. Theoretical activities in the area of control engineering include studies of linear and non-linear systems, robust control, algebraic methods, adaptive control, fuzzy set theory, and genetic algorithms.

The third stream, related to **management and economics**, is focused on supply chain systems management in the food and chemical business environments. The basic methods applied include the system approach, mathematical modelling, statistical methods, data mining, and dynamic simulation methods. Research results are implemented in food and chemical plants, or in distribution chains.

The fourth main stream of research activity performed at the faculty is focused on the **structural**, **spectroscopic** and **thermodynamic properties of environmentally or biologically important substances**. Computational chemistry is much used within this field: quantum chemistry codes, molecular dynamics packages and self-developed codes for statistical thermodynamics and molecular simulations run on two high performance computational clusters (200 and 50 cores). Research in computational chemistry is focused on the following topics: molecular geometries; thermodynamic properties

and spectroscopic characteristics of molecules; simulation of chemical reactions in the ground state; photochemical processes; determination of the structure of fluids; molecular modelling. Studies on experimental thermodynamic have produced high-quality experimental results in the following areas: phase equilibria, particularly in highly dilute solutions (limiting activity coefficients and Henry's law constants); the state behaviour of pure liquids and liquid mixtures (measurements up to 573 K and 30 MPa); membrane separation processes (sophisticated measurement of pervaporation and sorption kinetics); surface and interface phenomena; calorimetric data (heats of mixing, heats of phase transitions). The research laboratories are equipped with both commercial and self-developed apparatus constructed by expert staff.

The fifth research stream is focused on **physical, physicochemical and chemical measurements and analyses**, advanced separation techniques, molecular recognition applications, and physical and chemical sensors. In the area of sensors, activity centres on the preparation and characterization of chemical sensors with nanostructured active layers (receptors). The principal of molecular recognition is applied to the design of active layers based on both optical and electrochemical responses. Multichannel analysers (e.g. electrochemical tongues) are developed. The broad topic of sensor development includes: **(i)** materials engineering: the tailoring of new materials applicable for active layers (conducting polymers, organic metalocomplexes, nanoparticle composites), **(ii)** deposition techniques, especially MAPLD (Matrix Assisted Pulsed Laser Deposition) for layer preparation, **(iii)** the physical

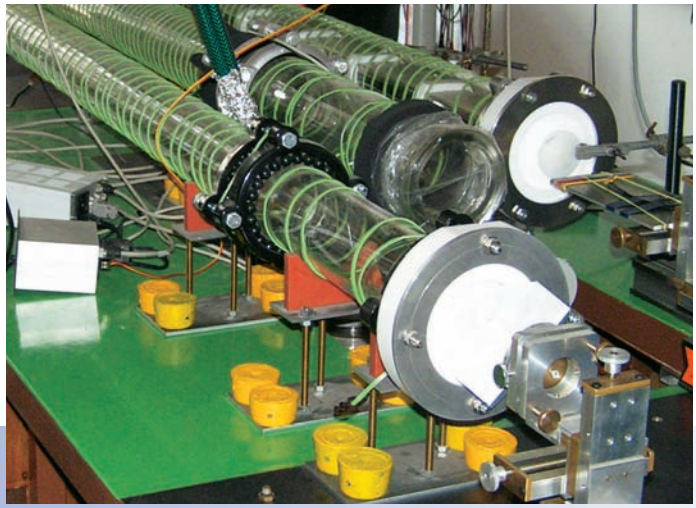


parameters of sensors (e.g. resistance, impedance) in systems with analytes, and **(iv)** the acquisition and processing of sensor response. Sensors with high sensitivity and good dynamic response to both reducing (hydrogen, alcohols) and oxidizing (ozone, nitrogen oxides) analytes are developed. Studies of molecular recognition applications cover chiral recognition, life-enabling intermolecular interactions, the preparation and use of molecular tweezers as receptors for electron-deficient compounds, the modification of metal nanoparticles for separation and medical applications, and the development of supramolecular systems for medical diagnostics and therapy.

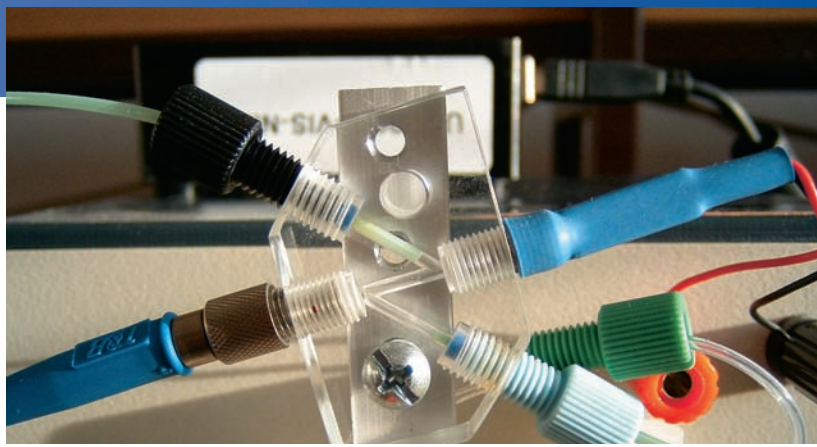
Research in the sixth stream (biospectroscopy; atomic, molecular and high resolution spectroscopy) is focused on the **advanced techniques and methodologies of modern spectroscopic methods**: speciation analysis of biological samples; inductively coupled plasma-mass spectroscopy (ICP-MS) coupled with liquid chromatography; various branches of vibrational spectroscopy, including surface-enhanced Raman scattering (SERS) and surface-enhanced infrared absorption (SEIRA) spectroscopies; chiroptical methods, i.e. vibrational and electronic circular dichroism (VCD and ECD) spectroscopies. Surface-enhanced spectroscopies represent powerful tools for the study of layers at interfaces that can serve as receptors and receptor-analyte associates in sensors. Chiroptical methods provide unique information about the structure of chiral substances (pharmaceutical products, alkaloids, proteins, oligonucleotides, nucleic acids, saccharides) independently of their molecular mass. Challenging applications of VCD spectroscopy include the structural analysis of chiral molecules, especially biomolecules and supramolecular assemblies, and the study of conformational changes induced by noncovalent interactions.

Attention is paid to the development of high resolution microwave spectroscopy, with particular emphasis on the remote sensing of molecules in space. The outstanding Prague millimetre wave spectrometer is an advanced semiconductor system designed to cover the spectral range from 12 to 700 GHz. And a unique low-frequency microwave emission spectrometer based on the Fabry-Perot interferometer has been developed for conformational studies of (bio)molecules. The laboratory is involved in the ALMA (the Atacama Large Millimetre/ Submillimetre Array) collaboration aimed at (i) investigating the composition of gas in interstellar space and the surrounding stars, and (ii) developing chemical models of the atmospheres of planets.

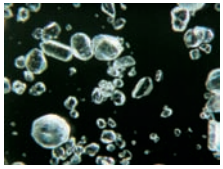
The research fields described above are tightly bound to the educational programmes offered by the faculty at all three study levels (B.Sc., M.Sc., Ph.D.). In fact, the faculty has a special place in the education of ICT Prague students as it provides bachelor-level education in the core subjects common to all students. Theses core courses combine education in the natural sciences (mathematics, physics, general chemistry) with engineering (chemical engineering, computer science, informatics, economics). Emphasis is placed on independent work in laboratories, and on developing an engineering way of thinking and a systematic approach to problem resolution. Students learn to use engineering, informatics and chemical software. Studies at the faculty are based on a credit system that allows students to choose from a broad range of elective subjects. The strong theoretical knowledge and experimental experience gained at bachelor level enables students to specialize during master's and doctorate studies, where they become deeply involved in advanced and inventive scientific research projects.

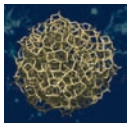


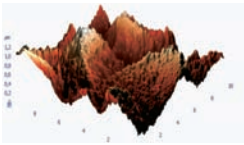
The bachelor degree programme **Chemistry** is targeted at students with a deep interest in chemistry. Both lectures and practical courses in the fundamental fields of chemistry are compulsory. The three key characteristics of the programme are: **(i)** the tutor system, **(ii)** teaching in small groups and **(iii)** research work in laboratories from the first semester. Graduates of this prestigious programme receive the title, Eurobachelor. The bachelor's degree programme **Engineering and Management** is divided into two subprogrammes: **(i) Process Engineering**, **Informatics and Management** and **(ii) Technical Physical and Analytical Chemistry**. The former is focused on the engineering of chemical and biotechnological processes, as well as on the application of computational techniques and information technologies. The latter centres on theoretical and practical aspects of modern analytical and physicochemical methods, including computational approaches. Specialized programmes in all of the abovementioned fields are offered at both master and doctorate levels. The bachelor degree programme **Engineering Informatics** is offered to students with a particular interest in computer techniques. Graduates of this area are skilled in the use of informatics and information technologies for the simulation and analysis of chemical, technological, environmental, bioengineering and biomedicinal processes. A follow-up master's programme **Applied Engineering Informatics** has recently been introduced, and focuses on artificial intelligence, modelling and software engineering with respect to chemical engineering and bioengineering data.



Study at the Faculty of Chemical Engineering offers several advantages. All subprogrammes at the faculty are of a universal character, without any firm link to a specific material, technology or area of production. The outstanding research profile of the faculty results in the substantial involvement of students in its scientific and research projects. By participating in research projects from an early stage of their studies, students get first-hand experience of innovative ideas, creative approaches and inventive enthusiasm. The faculty's many contacts with, mainly European, universities, its strong involvement in international research projects, and the Erasmus scheme all combine to give students an opportunity for international mobility. In selected cases, it is possible to obtain double or multiple diplomas. Graduates from the faculty find employment in various fields of the chemical, pharmaceutical and food industries, as well as in environmental and health protection. They enjoy careers in engineering, production, business, management, and research and development roles, amongst others.

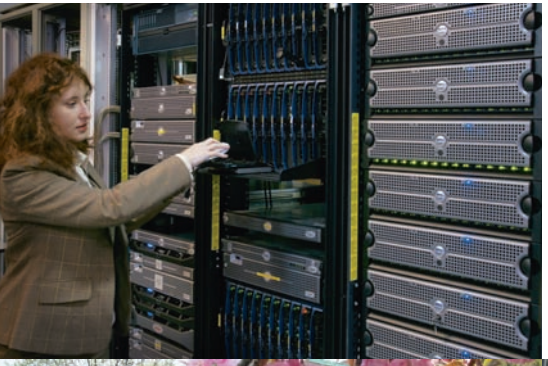
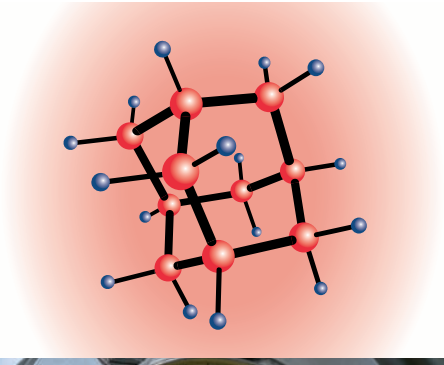


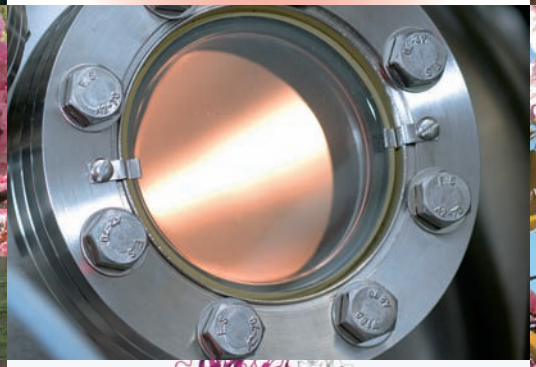


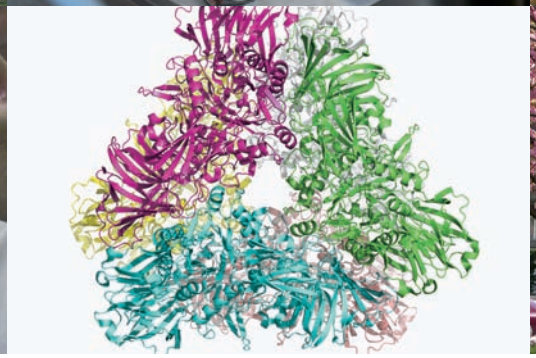


more information and pictures at

www.ict-prague.eu/fce


Service Departments for all ICT Prague Faculties

Service Departments for all ICT Prague Faculties

Department of Foreign Languages

The Department of Foreign Languages provides courses of English, German, French, Russian and Czech for Foreigners to students of all programmes. The courses are focused on scientific and professional communication.

The successful passing of an examination in a foreign language is compulsory for all students attending an undergraduate degree programme. The department also provides courses in Business English that lead to the award of a credit.

With regards to doctoral programmes, the department provides language courses that help postgraduate students prepare for their participation in the scientific conference held by their faculty. At this conference, which is held in English, doctoral candidates present the results of their scientific work in the form of a lecture, and prove their communication skills in the subsequent discussion, which is also conducted in English.

Based on the level of their knowledge, students can also sign up for optional courses in foreign languages.

Department of Social Sciences

The Department of Social Sciences offers courses in philosophy, economics, sociology, political science, modern history, psychology, and personnel management.

The primary aim of these courses is to help students view their field of study within a broader cultural, philosophical, social and economic context.

The department also organizes courses in the teaching of chemistry, running both parallel with other study programmes and in the form of postgraduate courses.

Department of Physical Education

The Department of Physical Education offers a number of compulsory and optional activities for students according to their individual interests: health-oriented physical education, aerobics, fitness exercises, swimming, canoeing, judo and self-defence, softball, baseball, volleyball, basketball, tennis, squash, football, indoor football, handball, cross-country and downhill skiing, mountaineering, rafting, orienteering, modern gymnastics, and bodybuilding.

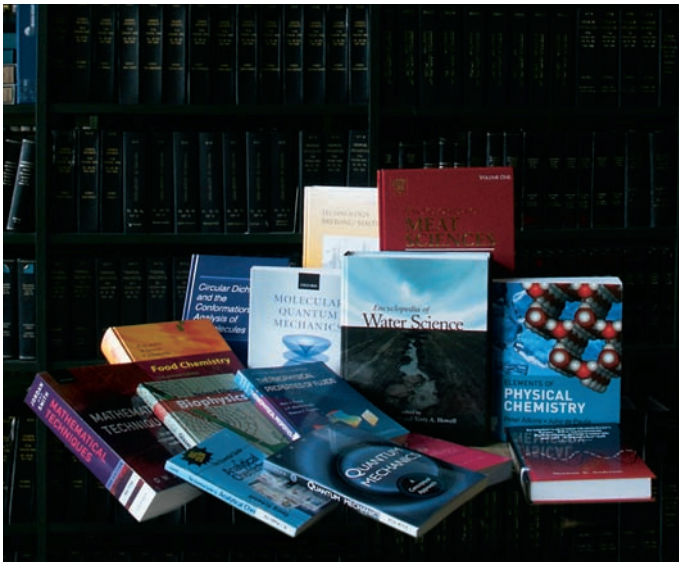
Students of all faculties may take part in a two-week winter or summer training course.

Students may take part in the many other events organized by the department, such as skiing courses and canoeing trips.

Central Library

Research at ICT Prague continuously generates new findings, while, at the same time, depending on and being driven by the enormous body of existing results. To illustrate, the Chemical Abstracts Service, the world's largest repository of chemistry-related findings, processes up to 2,000 new articles, patents, reports and other sources of information every day. Thus, it is evident that any modern institution of higher education must have a well-equipped library with fast and reliable connections to computer networks, both internal and external, that provide immediate access to the latest scientific findings, as well as to those published in the past.

The ICT Prague Central Library was one of the first chemistry-oriented institutions in Europe to install the electronic version of Chemical Abstracts on its local network. This resource provides constantly updated information and allows the user to search for information dating back more than 20 years. The Beilsteins Handbuch and Gmelins Handbuch, which cover the fields of organic and inorganic chemistry from the very beginnings of scientific chemistry at the end of the eighteenth century up to the present day, are now available via the CrossFire database in practically every ICT Prague workplace. As primary sources of information, these electronic databases enable both students and staff to formulate chemical problems in the form of structural formula drawn on screens, and to search for specified structures, either individually or as part of a reaction scheme.

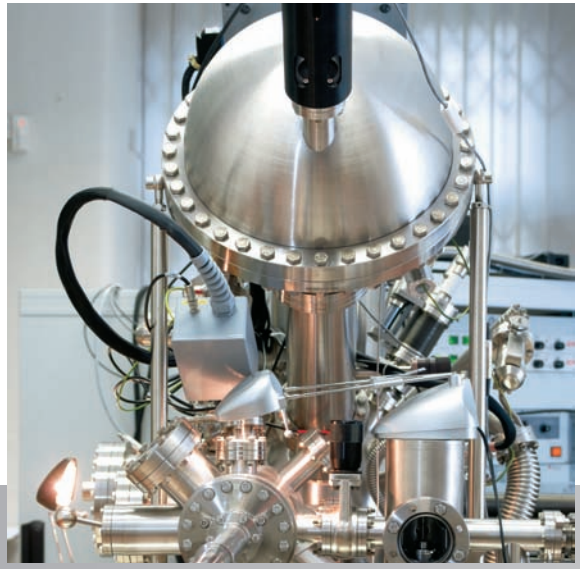


The ICT Prague Central Library provides free reference and lending services to people from all over the Czech Republic. It also provides fee-based information and inter-library lending services from practically all over the world. Its own collection is being electronically catalogued and made available to the public, along with other information, via a web server (**http://www.ict-prague.eu**, or directly: **http://lib-c.vscht.cz/intro_eng.html**).

In terms of traditional print media, the Central Library houses more than 250,000 volumes of books, handbooks, encyclopaedias, periodicals and other publications. More than 3,000 new volumes are added each year. In addition, the individual departments and other centres have their own reference libraries. The Central Library subscribes to some 500 professional periodicals, of which about 350 are published abroad. At present, around 2,000 scientific periodicals are available in electronic form, not only in the Central Library, but also via the local network at any ICT Prague workstation. The number of periodicals subscribed to is constantly increasing.

Central Laboratories

Although their requirements for laboratory analyses are often very similar, individual ICT Prague departments do not always have the resources for the necessary instrumentation and apparatus. ICT Prague resolves this problem by investing in its Central Laboratories, which currently consists of nine major laboratories: Mass Spectrometry, Molecular Spectrometry, Nuclear Magnetic Resonance, Atomic Spectrometry, Organic Elementary Analysis, X-ray Difractometry, Thermal Analysis, X-ray Fluorescence, Electron Microscopy and Microanalysis.



The Central Laboratories provide services to all of the faculties. Central Laboratories staff teach at all degree levels within individual departments. Apart from working with other ICT Prague departments in the implementation of scientific projects and being actively involved in the fulfilment of industrial contracts, Central Laboratories staff also conduct their own scientific research and pursue their own contractual work.

Computer Centre

The Computer Centre operates and develops a large computer network that links ICT Prague's various departments, laboratories, lecture halls, remote offices and student dormitories. It maintains and licenses classroom computers, and develops and implements information systems and technologies essential to the smooth running of the university. It is responsible for the security of ICT Prague's computer networks and information systems, along with the thousands of individual workstations and other devices owned by the university.

The Computer Centre not only organises network connection within the university, but also connections to the Internet and to the Czech Scientific and Educational Networks

(CESNET). As a member of CESNET, ICT Prague participates in various national and international development projects for the implementation of new technologies.

ICT Prague Press

ICT Prague Press is the only publishing house in the Czech Republic specializing in the publication of professional chemical literature, not only for ICT Prague students, but also for the broad professional public. It issues about 50 titles a year, including textbooks and collections from national and international conferences. It also participates in the publication of Czech and foreign language chemical periodicals. These publications may be purchased from the ICT Prague bookshop (Dejvice) and other specialist bookshops, or ordered online.

The staff of ICT Prague Press provide professional and technical editing services for Czech and foreign language publications. It has its own DTP studio with state-of-the-art hardware and software for the composition of highly demanding chemical and mathematical texts, for graphical and typographical picture processing, and for the large-format printing of professional posters

designed for the presentation of scientific results, both in the Czech Republic and abroad.

ICT Prague Press offers a variety of audiovisual services, such as the processing, copying and distribution of teaching videos and DVDs. These teaching programmes are also distributed to secondary schools on request.

Apart from well-known technologies and forms of content distribution, ICT Prague Press is an active researcher in new forms of publishing; not only from a technical standpoint (most of the content is available online in full text form, with some texts implemented as highly interactive online applications), but also from a legal perspective, with ICT Prague Press promoting the importance of open licences (Creative Commons licensing) for the publication of scientific works.

How to Become a Student of the Institute of Chemical Technology, Prague

How to Become a Student of the Institute of Chemical Technology, Prague

B.Sc. and M.Sc. Programmes

Study programmes are open to students from abroad. Information on the programmes available for foreign students is provided by the Department of International Relations (see contact addresses on page 119).
The study system at ICT Prague is fully compatible with the ECTS system.

Foreigners seeking to attend courses delivered in Czech may study under the same conditions as citizens of the Czech Republic i.e. free of charge providing that, as part of the admission procedure, they are able to prove sufficient command of the Czech language. ICT Prague provides optional Czech language courses for foreign students. Students studying in English are obliged to pay a study fee of approximately 2500 Euro per semester.

Tuition-paying students must also pay the full cost of their health and accident insurance, as required under Czech law. Upon request, the institute may provide the student with inexpensive accommodation in the halls of residence and discounted meals in student canteens. The fees for accommodation and meals are set by the administrative bodies of the halls of residence and student canteens. When negotiating insurance policies, seeking health certificates and arranging for a long-term residence permit, students may seek assistance at the Department of International Relations.

Foreign students who successfully complete their B.Sc., M.Sc. or Ph.D. programme are awarded a degree. Exchange visits and short-term courses for foreign students are organised on an individual basis. Further information, together with an application form, is available from the Department of International Relations (see contact addresses on page 119).

The entry requirements for all study programmes are listed under the

"Prospective student" menu at http://www.ict-prague.eu.

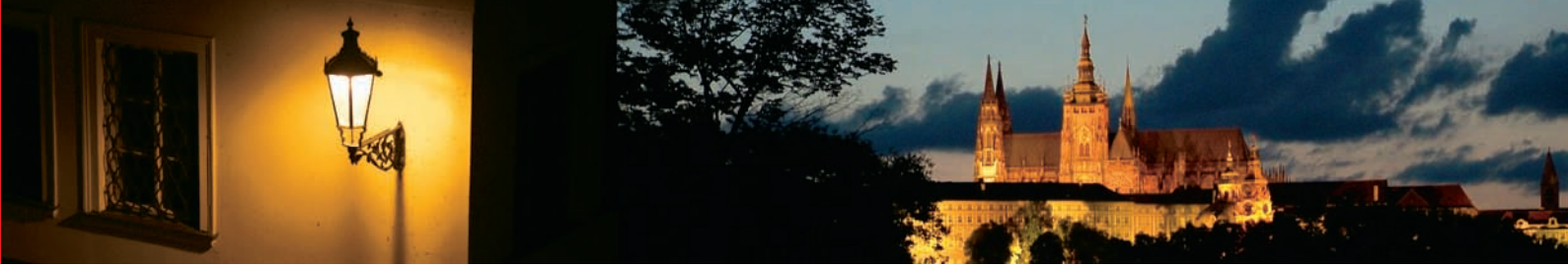
Students applying for admission to a B.Sc. programme at any faculty must have completed their secondary education, i.e. they must submit a General Certificate of Secondary Education or a School Leaving Examination Certificate. Applicants must deliver a verified list of results achieved at secondary school in chemistry, mathematics and physics, or similar disciplines.

Students applying for admission to an M.Sc. programme must submit a certificate of their bachelor's degree (Diploma and Diploma Supplement), obtained in a related field of study at a university equivalent to ICT Prague.

They must submit their application to the Department of International Relations by April 30th of the calendar year in which they wish to begin their studies. Further information on the admission procedure may be obtained from the Department of International Relations (see contact addresses on page 119). A fee is applicable for administering the formalities related to the admission procedure.

Ph.D. Programmes

All faculties enrol students for postgraduate doctoral programmes in a given field of study. Candidates for admission must have a master's degree in the given field, or in a related field, from either a Czech or foreign



university. The list of study topics and the date of admission for the given academic year are announced every year in both Czech and English on the ICT Prague website. Applications for entry should be submitted to the Department of International Relations.

Admission interviews usually take place in April, prior to the academic year in which the course of study is to begin. Candidates seeking admission have to prove their ability to study in the given field and their qualification for independent scientific work. Taking into account the commission's opinion, the dean of the relevant faculty makes the final decision on admission to postgraduate courses.

ICT Prague grants students of on-campus doctoral programmes studying in Czech language a basic scholarship that covers their living costs.

Student Welfare at the Institute of Chemical Technology, Prague

Accommodation

ICT Prague owns the Volha and Sázava halls of residence at the largest university accommodation complex in Prague, the so-called Jižní Město-Chodov Halls of Residence. These halls of residence are able to accommodate most students from outside Prague during the academic year. Students

are accommodated in bedrooms that consist of two or three beds, a private bathroom and a kitchenette. Computer access to each room is provided.

The residential centre comprises a canteen that provides all daily meals, a number of sports facilities (tennis courts, a softball field, fitness centres, a sauna), and several students' clubs.

The Students' Residential Self-Administration Council, an organization of elected student members, ensures that student interests are represented when dealing with the management of the Halls of Residence. The council helps accommodate students and facilitate their life at the residential centre.

The Jižní Město-Chodov Halls of Residence are connected to the seat of ICT Prague at Dejvice by the Prague metro system (students use the C and A lines to commute from Chodov metro station to the Dejvice terminal). It takes about 45 minutes to get from one place to another, including a short walk to/from the metro station.

Transport between the halls of residence and the centre of Prague is also very easy via metro line C. Students are entitled to discounted travel passes valid for all means of public transport.

Catering

Students are entitled to significant discounts in any student canteen located near the institute. The price of meals is subsidized by the state.

Insurance

All students are insured against permanently disability and fatal injury. The insurance policy covers all activities relating to the student's study plan.

Student Leisure Activities

Sports Events

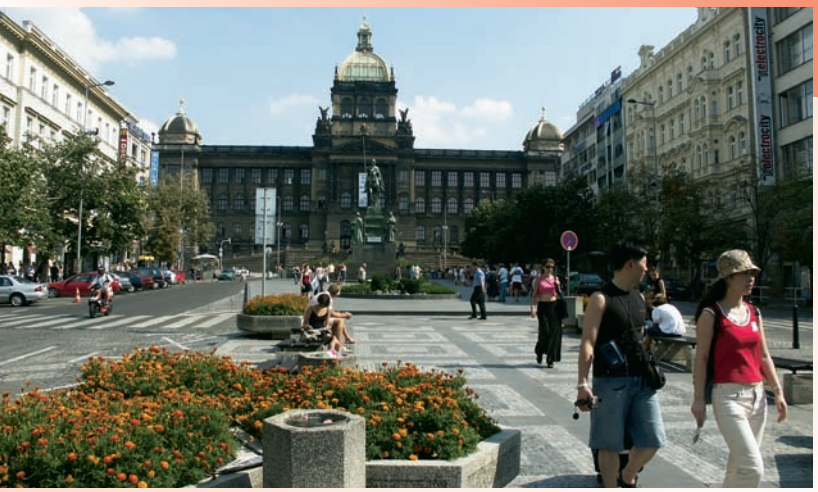
ICT Prague offers its students a broad range of sports activities provided by the Department of Physical Education. The most popular sports include volleyball and basketball, together with swimming and softball. Many students are keen on bodybuilding and various forms of aerobics.

A number of sports contests and tournaments take place at the Jižní Město-Chodov Halls of Residence complex every year on the occasion of Rector's Day. The most popular competitions are in volleyball, football, foot volleyball and aerobics.

The sports club Chemie Praha (Chemistry Prague) has achieved various notable successes, particularly in softball. The women's softball team has won several national championships, and has even enjoyed success at the European Women's Softball Cup.

Access to Computers

Every student may apply for his/her own free e-mail account. All students have access to computers in computer rooms that are open both during and after lesson hours. To search for information relating to their studies, students may use the computers in ICT Prague's Central Library, as well as the computers in their individual departments.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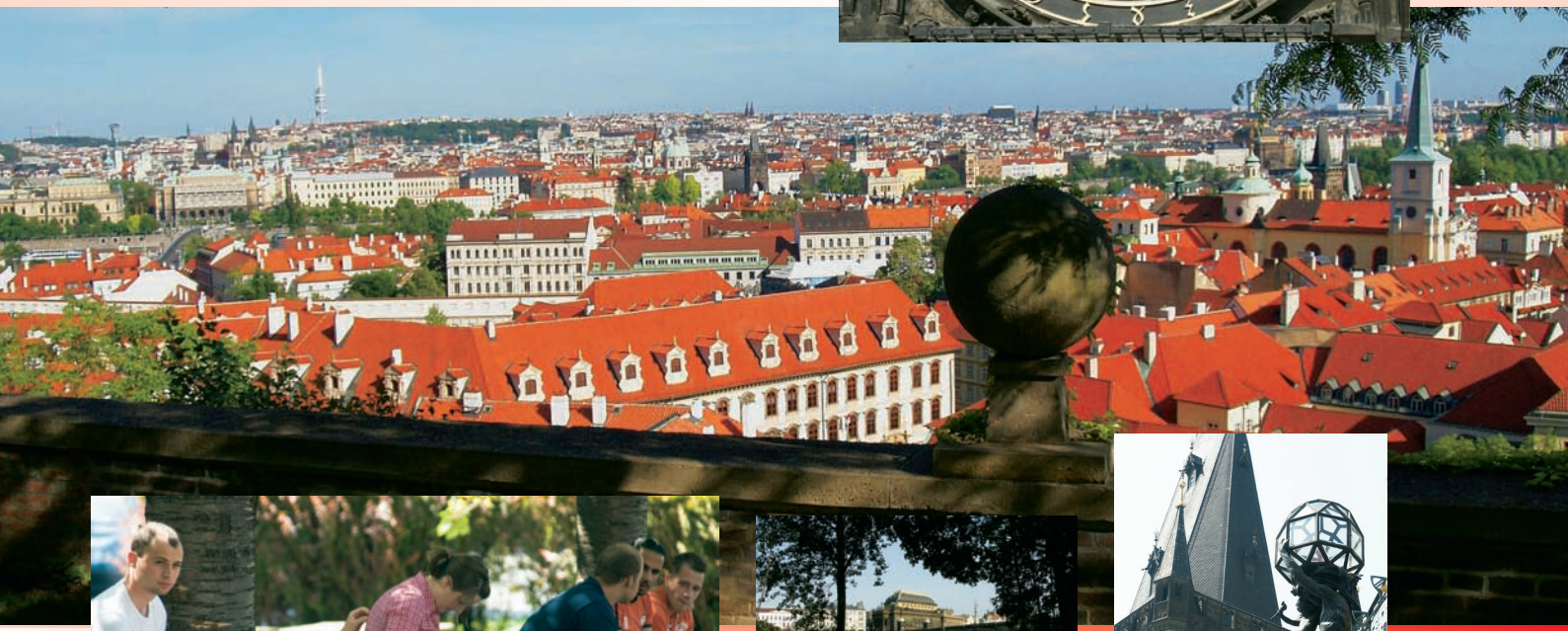

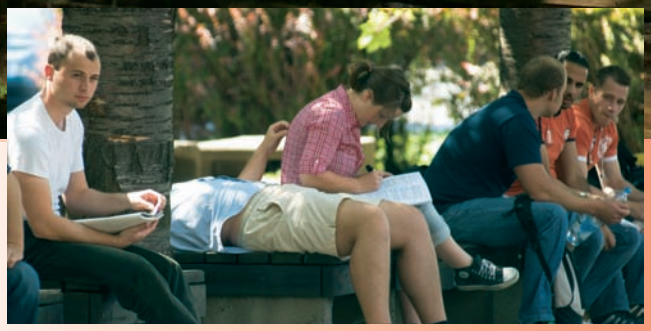

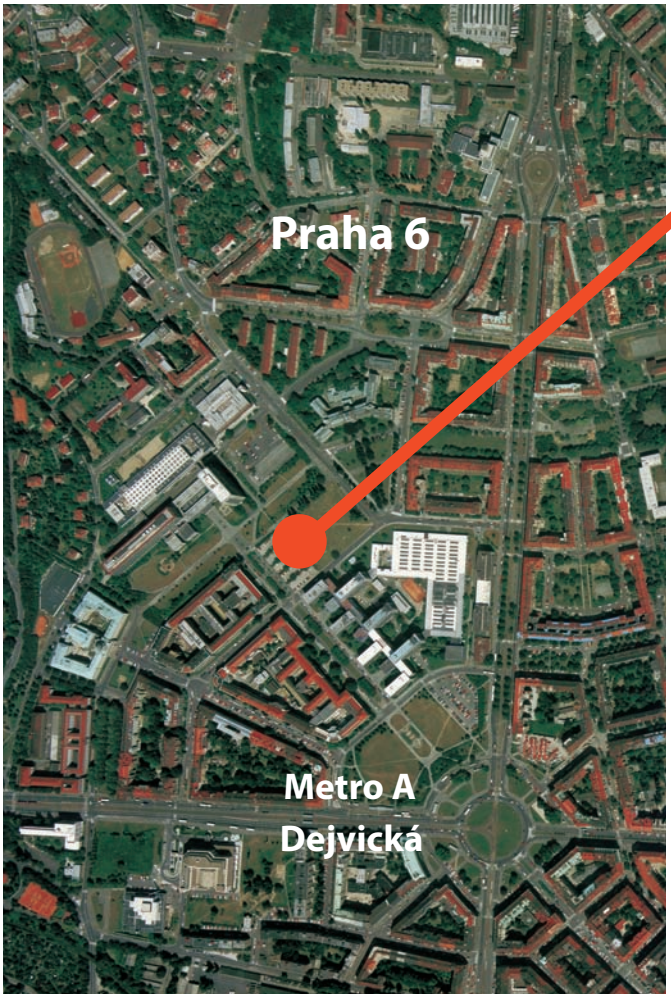

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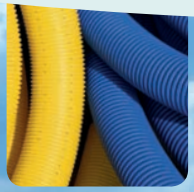

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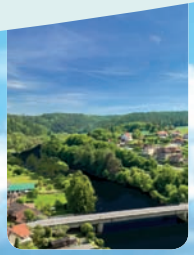

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