RADIOLOGICAL TECHNOLOGY AND RADIOLOGICAL PHYSICS PROGRAMMES AT THE FNSPE CTU PRAGUE

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Medical use of ionising radiation:

- radiation diagnostics (using external radiation beams),
- radiotherapy (using external radiation beams or internal radiation sources in case of brachytherapy)
- nuclear medicine (using internal radiation sources both for diagnostics and therapy).

- The exposure is intentional and for the direct benefit of the patient - there are no fixed limits of exposure similar as for occupational exposures and exposures of public.
- In radiation therapy, the biological effects of high dose radiation (cell killing) are used to treat cancer and other diseases. This needs delivery of the required dose exactly to the volume to be treated, avoiding unnecessary exposure of healthy tissues.
- In diagnostic procedures, this means balanced compromise between the best diagnostic information and minimum exposure of the patient.

The fact that ionizing radiation is used for diagnostics or therapy puts extraordinary demands on both physicians and technicians and physicists without close cooperation of whom these areas of medicine would not be practicable.

The bachelor's degree course in Radiological Technology focuses on medical tools using ionizing radiation for diagnostic and therapeutic purposes.

The course consist of three subject areas: **radiodiagnostics, nuclear medicine, and radiotherapy.**

The radiological technologist's main concern in health care is radiation protection in performing routine programme procedures (including dosimetric measurements) and especially in assisting the radiological physicists. In practice, this means performing operation stability tests or long-term stability tests of medical instruments using ionizing radiation, preparation of local radiological standards, determination of local diagnostic reference levels, participation in and introduction of new diagnostic methods, calculations of doses received by patients, etc.

Linear accelerator for radiotherapy

- Knowledge: Great emphasis is placed on mastering the know-how for using ionizing radiation for diagnostic and therapeutic purposes. Due to the orientation towards health care, the graduate learn also the essentials of medical disciplines such as anatomy, physiology, human body biology, biochemistry, and pharmacology. When working on the bachelor´s project, the students come into direct contact with staff members of institutions relevant to the field and are acquainted with the latest developments. Part of the degree course is also principles of legislation related to radiation protection and handling ionizing radiation sources in health care.

- Competency: The graduates are prepared for the position of radiological technologist at departments of radiodiagnostics, nuclear medicine and radiation therapy or at departments of medical physics or radiation protection in hospitals. Due to their knowledge of the physical principles of radiation protection and its related legislative frame they also can find jobs at workplaces on radiation protection and safety.

Gamma camera

- The master´s degree course in Radiological Physics was accredited as the first course of its kind in the Czech Republic in 2005, offering a medical programme according to Act 96/2004 Coll. on non-medical support staff. A bachelor´s degree course Radkiological technology stresses engineering, here the graduate´s competences lie in radiological physics, namely in the competence to perform the profession of radiological physicist. The curriculum concerns to professional and medical subjects and includes on-the-job experience and training in medical centres. The course is designed so extend knowledge of general mathematics, physics and informatics, and give a more profound knowledge of nuclear physics, physics of ionizing radiation, detection and dosimetry of ionizing radiation with a view to health care. The students familiarise themselves in detail with the use of ionizing radiation for diagnostic and therapeutic in health care, the physical and technological principles of modern imaging techniques in medicine and advanced radiotherapy using radionuclides, radionuclide irradiators, linear accelerators and other specific radiotherapy equipment.

PET scanner

- Close contact with the latest trends in the field is assured by research for the master’s thesis done in cooperation with medical institutions in the Czech Republic. Graduates also get a broad overview in the principles of legislation related to radiation protection and handling and operating ionising radiation sources in terms of human health. The graduates are ready to apply for positions of radiological physicists in departments of radiology, nuclear medicine, and radiotherapy or in the departments of medical physics and/or radiation protection in hospitals. They closely collaborate with the medical staff and health professionals in administering diagnostic and therapeutic procedures, namely in the physical and technical aspects. The course programme also trains students for positions focusing on nuclear safety and radiation protection. It is designed in accordance with and complies with the standards and recommendations of the European organisations of medical physics.

NMR scanner

Bachelor course Radiological technology - recommended important subjects in the first year - basic subjects from mathematics and physics, but also basic subjects related to biology and medicine are included (subject, number of hours of lectures, number of hours of exercises):

Mathematics (1st and 2nd part)	104	52
Mechanics	52	26
Principles of physical measurements	26	26
Basics of working with a computer	-	26
Basics of programming	26	26
Electricity and magnetism	52	26
Principles of radiation physics (1st part)	26	26
Basics of preventive medicine for technicians	13	-
Principles of ethical behaviour in health care	13	-
Fundamentals of human biology, anatomy and physiology	26	26
Basic first aid techniques for technicians	-	26
Practical exercises – general physics	-	52

Dose calibrator for nuclear medicine

Bachelor course Radiological technology - the second year:

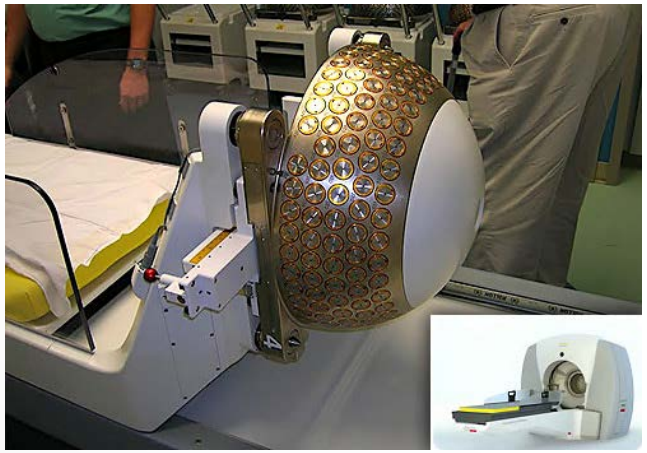
Mathematics (3rd and 4th part)	52		52		
Probability and mathematical statistics	26		26		
Principles of radiation physics (2nd part)	26		26		
Basics of dosimetry	52		52		
Nuclear power installations and accelerators	26		-		
Numerical methods (1st part)		26			26
Principles of integrating dosimetric methods	26		-		
Ionising radiation detectors	52		-		
Processing of experimental data	26		-		
Introduction to quality management system in healthcare	13		13		
Clinical propedeutics	26		-		
Medical informatics for technicians	13		13		
Non-radiation imaging methods	26		-		
Health risks of ionising radiation	26		-		
Practical exercises – radiation physics	-		26		

Scheme of a proton therapy centre

Bachelor course Radiological technology - the third year:

Numerical methods (2nd part)	26	26
Radiation protection	52	-
Automatic data processing	-	26
Practical exercises – detection and dosimetry	-	52
Radiological technology – nuclear medicine	26	13
Radiological technology – diagnostics	26	13
Radiological technology – radiotherapy	26	13
Clinical dosimetry for technicians	26	-
Overview of healthcare legislation	26	-
Clinical practice – nuclear medicine	-	80
Clinical practice – diagnostics	-	80
Clinical practice – radiotherapy	-	80
Bachelor thesis seminar	-	26
Bachelor thesis	hours not specified	

Gamma knife



Master course Radiological physics - the first year:

Additional parts from mathematical analysis (1st and 2nd part)	52	52
Waves, optics and atomic physics	52	26
Equations of mathematical physics	52	26
Quantum physics	26	13
Nuclear and radiation physics	26	13
Statistical physics and kinetic theory	26	26
Monte Carlo method in radiation physics	26	26
Image processing and recognition (1st part)	26	26
Clinical dosimetry	26	-
Radiobiology	26	-
Pathophysiology and imaging methods	26	-
Professional excursions	-	39
Seminar project	hours not specified	

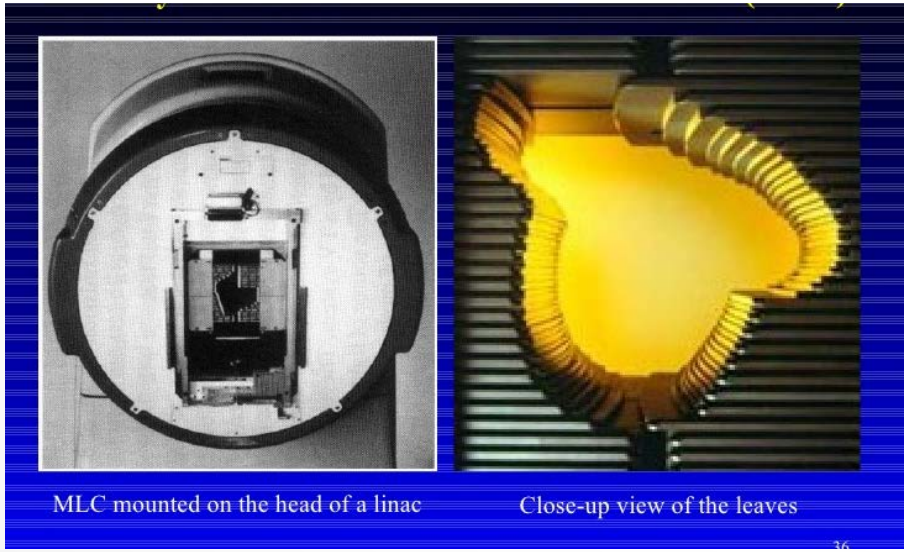
Cyberknife

Master course Radiological physics - the second year:

Image processing and recognition (2nd part)		26	13
Radiological technology – nuclear medicine		26	13
Radiological technology – diagnostics		26	13
Radiological technology – radiotherapy		26	13
Programming in radiological physics		-	26
Standards and metrology		26	-
Health technology assessment		26	-
Diploma thesis seminar	-	26	
Diploma thesis		hours not specified	

In addition, two languages (English and the other optional) and social sciences are included in the programmes.

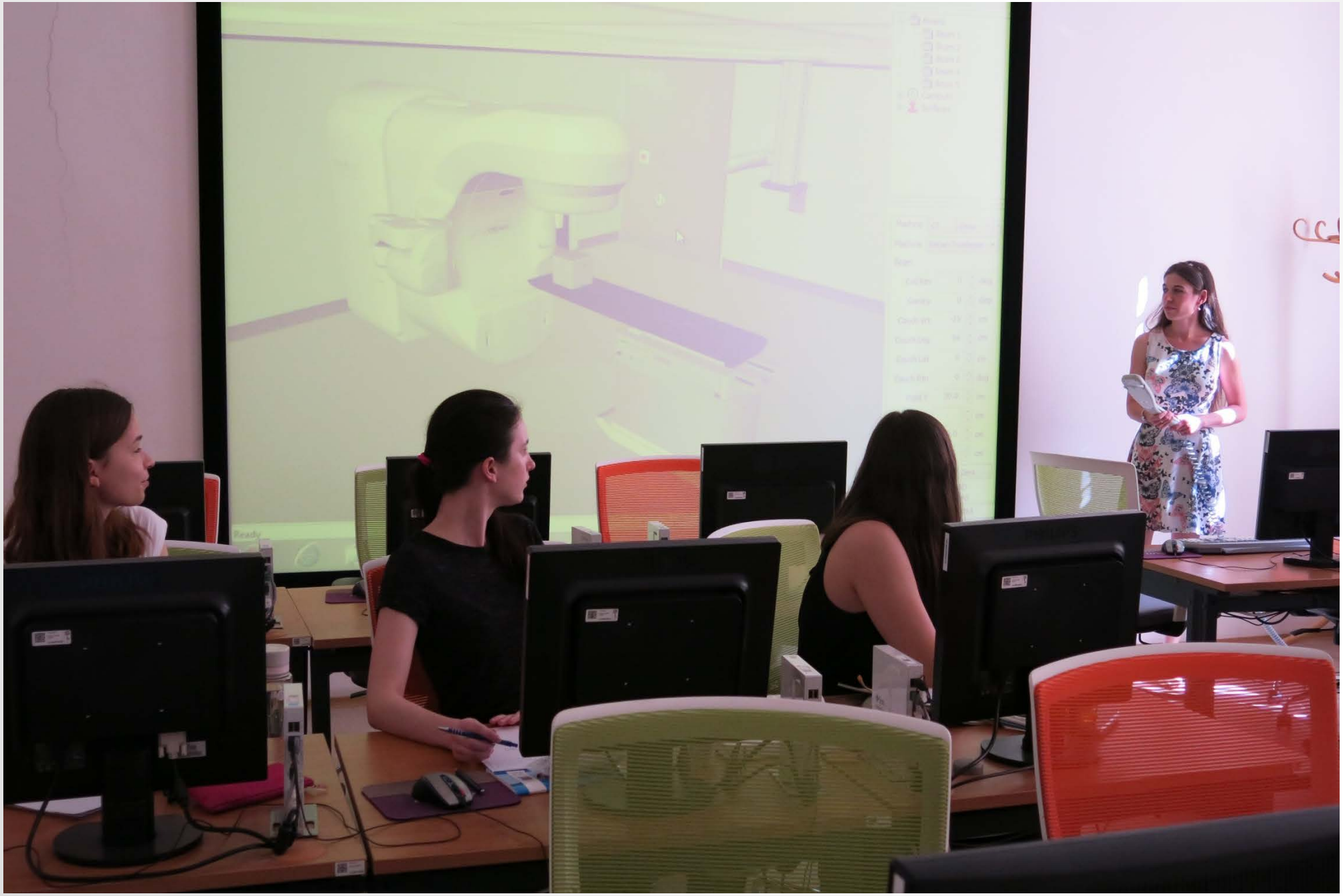
IMRT multileaf collimator



A unique teaching equipment for the Radiation Technology and Radiation Physics programmes as well as other teaching in this field - a medical linear accelerator simulator - the only one of its kind in the Czech Republic.

What does it knows (slightly reduced from the supplier‘s advertising documentation):

- Teach the theoretical concepts of radiation therapy with an innovative interactive training solution.
- Provides a safe, non-pressured environment for students to practice set up and technique.
- Reduces real-world Linac time required for training. Train students with the latest technology.
- Provides a viable and engaging alternative to visitors and staff needing to see a Linac.
- Teach using real pendant controls and touchscreen controls.
- Training in cross sectional anatomy. As a review tool for existing and developing techniques.
- Deliver continuing education sessions in the clinic. Help staff to refresh knowledge and develop further skills.
- Explain complex theoretical concepts and principles in a highly visual environment.
- Patient-centric 3D visualization of structures, dose, CT, and beams of RT plans for demonstration and explanation of radiation therapy techniques.



STRENGTHS:

- Radiological physicists and technicians are the “scarce goods”. Due both to introducing new methods and instrumentation and the Czech legislation, especially the so-called „Atomic law“ and related regulations, hospitals urgently need them.
- CTU-FNSPE is the only faculty in the country, offering this study programmes. Due to its demandingness both for teachers and equipment, it is not easy to prepare similar programmes in comparable quality.
- High quality of the programmes is guaranteed by wide collaboration of physicists from the FNSPE, physicists and physicians from hospitals, and physicians from medical faculties.
- The programmes are not only accredited by the National Accreditation Office at the Ministry of Education, but also recognized by the Ministry of Health; the graduates are accepted as a medical staff in the “hierarchy” of workers in medicine, with positive consequences on their job and salary classification.
- Themes of theses usually have strong relation to real practical problems. For medical physicists, they are usually on high scientific level and many of them allow continuing with related topic as themes of PhD. dissertations.
- The programmes are “gender balanced”. Women represent about one half of all students.

WEAKNESSES:

- The programme is very demanding from the point of view of both time and intellectual load of students. Though interest to enrol is high, the number of successful graduates is lower than the needs of medical institutions. The problem arises especially with radiological technicians, who start university studies, because the way of study and workload are significantly different from high schools and many students are having difficulty getting used to this change.
- From organisational point of view, it is difficult to put together the time schedule. Calendar of teachers from various institutions usually does not give much freedom. Organizing and integrating practices at medical institutions iare also difficult.
- Specialists from different branches feel competent to comment the structure of the programme and ask for shifting the composition closer to that part they are dealing with. Programmess are currently being prepared for periodic re-accreditation, and this has been fully demonstrated in the preparation of accreditation documents.
- As the programme is taught not only by teachers from FNSPE, but also from other institutions, personal expenditures for external lecturers are high. Material expenses for such type of programme are also relatively high. E.g., the cost of the accelerator simulator was about 240 000 EUR (paid mostly from the European project).

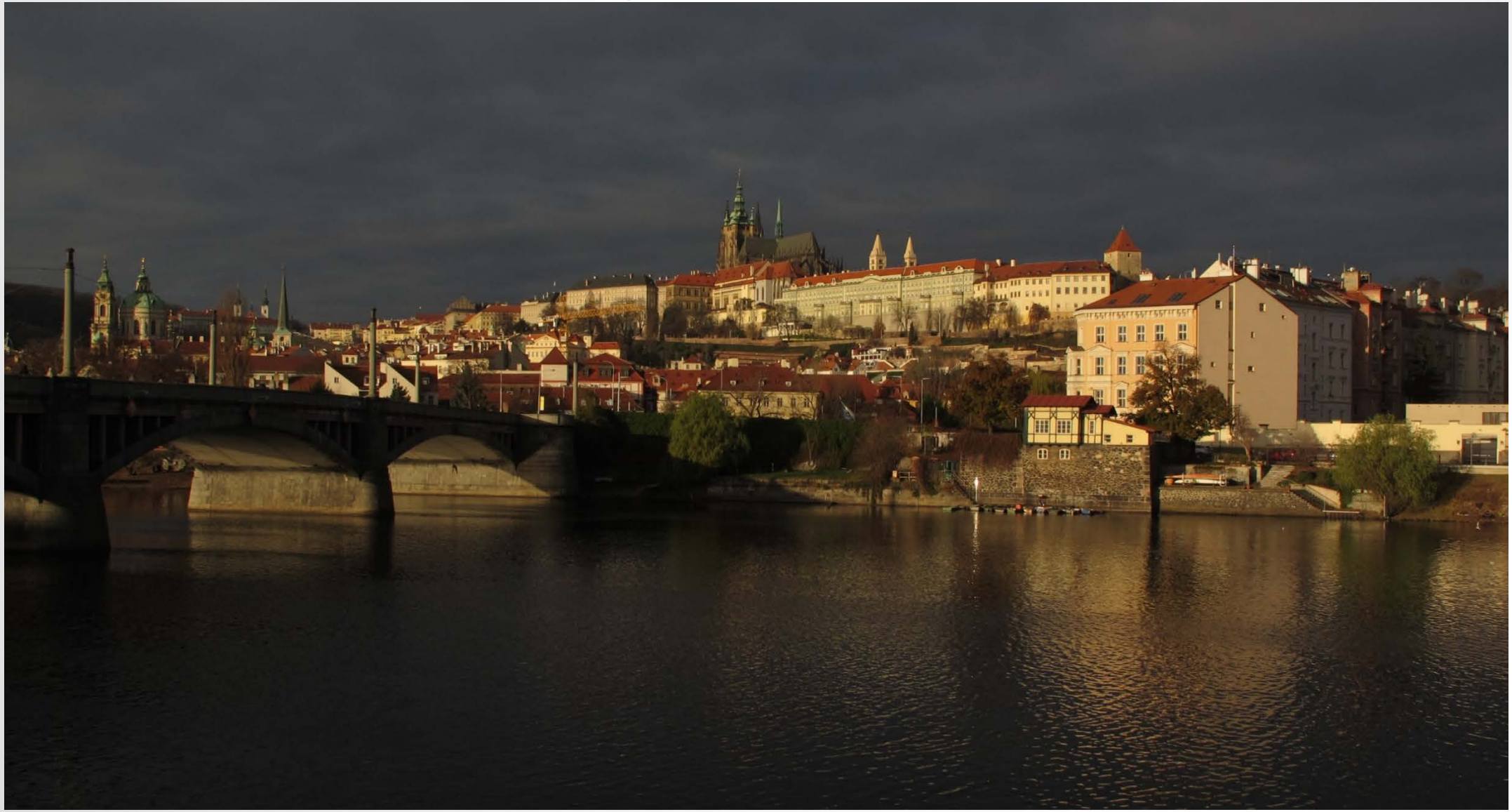
OPPORTUNITIES:

- The programmes expand activities of the technical university into interdisciplinary field related to human health and thus enables attracting young people, who in the other case would not think about engineering studies.
- Collaboration with medical and biological institutions enhances professional experience of our staff and extends fields of possible research activities.
- High quality programme of this type increases prestige of the university both in public and in non-technical professional spheres.
- Medical physics is a branch of science with long history in the international environment. Intensive exchange of experience and optimizing practices is carried out and international societies of physicists in medicine (e.g., EFOMP in Europe) are well organised and influential. Therefore activities in this field bring new opportunities of interesting international contacts and collaboration.
- Medical aspects of ionising radiation can help to improve the negative view of public to everything, what has an attribute “atomic” or “nuclear”. Even people from Greenpeace can sometimes be patients at clinics using radiation, need X-ray examination, etc. Therefore, medical applications of ionizing radiation are probably the only applications that are accepted without any problems or protests of various activists.

THREATS:

- There is a strong competition between Czech higher educational institutions, fuelled among other things by permanent under-funding of education in the country and by the system of distributing funds among the universities, where the number of students play the key role. The successful study programme can give rise to an idea to prepare some similar programme, easier, with less mathematics and physics, and to press its accreditation by well organised lobbying. As most of young people nowadays are not fans of hard sciences, such programme would soak up some students to its lower quality, but easier way of education and obtaining an academic degree.
- As the programmes are expensive, it might happen that their funding will be or insufficient, or at the expense of other programmes. Such way, they can become untenable in the existing extent and quality.
- Similarly as all collaborations, this one is also based mostly on good personal relations. They can be influenced by retirement or change of employer of some key persons. Looking for new contacts necessary for arrangement of teaching and especially for practical training can be difficult and take some time.

Thank you for attention



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